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# Student professional development: Competency-based learning and assessment in an undergraduate industrial technology course

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**Student professional development: Competency-based learning and assessment  
in an undergraduate industrial technology course**

by

**Jacquelyn Ann Baughman**

A dissertation submitted to the graduate faculty  
in partial fulfillment of the requirements for the degree of

**DOCTOR OF PHILOSOPHY**

Major(s): Industrial and Agricultural Technology  
Biorenewable Resources and Technology

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Ames, Iowa

2012

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This dissertation is dedicated to

Michael Dodd, my dear uncle, a proud Aerospace Engineering graduate of Iowa State University, and an inspiration to all blessed to have known him.

Gerald Baughman, my dear grandfather, who provided a lifetime's worth of cherished childhood memories, and was always proud of "his girls."

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## ABSTRACT

Student professional development attempts to address the gap between academic experiences and employer expectations. This study examined student professional development utilizing competency-based development and assessment within an academic environment. An undergraduate course in lean/cellular manufacturing at Iowa State University served as the site for this mixed methods study. Degree program outcomes linked to workplace competencies were the foundation for implementation of a 360-degree assessment process. A pre-course survey showed that students had no prior experience with the 360-degree process. The workplace competencies' key action items were assessed during the semester using pre- and post-assessment formats. Analysis utilized paired *t*-testing to detect significant differences between the pre- and post-assessments average values. Results indicated professional development gains were achieved through higher post-assessment values in specific key action items within the competencies.

Students indicated that their 360-degree feedback experience had issues in the areas of benefits, difficulties, learning, fairness and accuracy, as well as impact on professional development. Self-reflections captured students' perceived lean knowledge gains, peer assessments as fair/accurate and valuable, and that the most helpful to their professional development was the industry project mentor experience.

Overall, this mixed methods study provided a framework to measure and understand professional student development through: (a) competency-based assessments, and (b) captured student experiences.

## CHAPTER 1. INTRODUCTION

The National Association of Manufacturers (NAM) policy positions, approved by the Board of Directors, represent views of a broad section of leaders in manufacturing. An excerpt from NAM's Education and the Workforce Policy, HRP-01, summarizes its views and concerns:

Manufacturers have identified the basic or core competencies necessary for workers to succeed in virtually all entry-level jobs across sectors within manufacturing. NAM believes that a system of industry-recognized skills credentials is necessary to reform education and training for 21st century manufacturing by providing skills assessments, standardized curriculum requirements, and portable credentials that validate the attainment of critical competencies required by industry. (NAM, 2012)

Providing students with a glimpse of workplace realities requires a clear understanding of the employer expectations and an assessment process. Because most college-aged students are entering adulthood, the attitudes, interests, values, and character development that underlie their behaviors may not be at the professional level (Hayward, Noonan, & Shain, 1999). Professional identity development is gained through the process of professional socialization in which an individual learns to adopt the values, skills, attitudes, norms, and knowledge needed for membership in a given society, group, or organization (Merton, 1957).

Student development has been described as “the ways that a student grows, progresses, or increases his or her development skills as the result of enrollment in an institution of higher education” (Rodgers, 1990, p. 27) and is about becoming a more complex individual (McEwen, 2005). The complementary theory used to explain and

understand student development allows educators to “proactively identify and address student needs, design programs, develop policies, and create healthy environment that encourage positive growth in students” (Evans, Forney, & Guido-DiBrito, 1998, p. 5).

### **Purpose of Study**

This study examined competency-based learning and assessment as a measure of student professional development. Specifically, the overarching purpose was to measure professional development through competency-based assessments and capture student perceptions. An additional goal was the development of a framework for competency-based development and assessment for higher education environments. Both quantitative and qualitative data are important for reporting purposes and as input into curricular improvement. This is clearly evident in ATMAE’s *2011 Outcomes Assessment Accreditation Model* which “requires that consideration be given to both the qualitative and quantitative criteria set forth in these standards” (p. 3). Increasingly, accreditation requirements challenge faculty to look ahead to anticipate emerging skills or a change in the emphasis on certain skills that could impact the preparedness of engineers and technology graduates for employability in the knowledge-intensive workplace. Unfortunately, little effort has been expended on looking ahead; it has been hard enough bringing students up to the current levels of skill preparedness expected by employers (Hanneman & Gardner, 2010).

A secondary purpose of this study was to develop a framework for holistic student professional assessment and development. A number of empirical studies of on-the-job excellence have clearly and repeatedly established that emotional competencies—communication, interpersonal skills, self-control, motivation, etc.—are much more important

for superior job performance than are cognitive and technical abilities (King & Skakoon, 2010). In his book, *Working with Emotional Intelligence*, Goleman (2005) cited numerous studies that indicated emotional competencies are twice as important in contributing to excellence as are pure intellect and expertise. Familiarity with what employers require of graduates will be an increasingly important intelligence for institutional researchers in the foreseeable future (Paulson, 2001).

Research is needed to examine the integration of academic and experiential learning (Hayward & Blackmer, 2007). This study stems from the researcher's 20 years of industry experience that culminated into a passion for preparing students for workplace expectations. This impacts not only their initial entry but also their success in future career pursuits. This led to the central research hypotheses:

H(1): Student professional development can be measured using competency-based assessment tools.

H(2): Student professional development can be understood and measured by capturing student experiences.

H(3): A student professional development and measurement framework utilizing an industry-based, 360-degree competency assessment process can be integrated into a higher education environment.

H(4): A holistic student lean professional development and assessment framework can be accomplished through a "backward design."

## **Methodology**

### **Background and Design**

This study was completed over one semester (16 weeks) and involved senior-level undergraduate industrial technology students in a lean/cellular manufacturing course. The study's four central hypotheses were addressed using mixed methods. As an approach to

accreditation requirements, the department collaborated with Developmental Dimensions International (DDI), a global provider of competency-based performance management tools and services. From this work, 14 unique workplace competencies were originally developed, with seven identified as “core” competencies, which were regularly mentioned by employers (<http://learn.ae.iastate.edu/Competencydefinitions.pdf>). The 14 competencies were mapped directly to degree program outcomes. Each competency was defined clearly, concisely, and independently. Specific to each definition, a set of observable and measurable key actions was developed. The department’s approach to accreditation produced two critical components for this research study’s success: 14 workplace competencies and a competency-based assessment format.

The first critical step in the design of this research was to select the workplace competencies to be used in the 360-degree assessment process. This was accomplished through a review of the course workplace competencies linked to the degree program outcomes. Based on previous stakeholder assessment feedback, all 14 workplace competencies would not be utilized for the 360-degree process. Thus a review of the course “core” competency frequency, coupled with the instructor’s 360-degree assessment industry experience, was used to select five competencies. They were labeled the “top five” course competencies: (a) analysis & judgment, (b) communication, (c) initiative, (d) continuous learning, and (e) teamwork (<http://learn.ae.iastate.edu/Competencydefinitions.pdf>). Additionally, of the two “core” competencies not included in the 360-assessment (technical knowledge, general knowledge), technical knowledge would also be self-assessed directly using a pre-/post-format. The top five course competencies were the foundation for the

implementation of a 360-degree/multi-rater assessment process. The crux of this process is self-development through multiple assessments, both “self-” and “others,” as views of performance. This can include peers, supervisors, customers, subordinates, etc.

Competency-based assessment and feedback has become a predominant workplace reality, commonly used as an organizational development tool for the learner (McCarthy & Garavan, 2001).

Key actions associated with each competency were assessed utilizing the department’s Likert-scale format. These assessment ratings were based on how often a key action was performed, ranging from 1 to 4 with 1=never or almost never, 2=seldom, 3=sometimes, 4=often, and 5=always or almost always. All top five competency assessments results were reported using the average result for each of the key actions. This background provided a perspective on one vital piece of the professional development course design intent. The following paragraph presents a guided tour through the course which highlights the methodology.

Students were introduced to the course design and timelines outlined in the syllabus on the first day of class. This included a review of the top five course competencies and assessments throughout the semester. It was ascertained that, as senior-level students, they were knowledgeable not only about the department’s workplace competencies but also the competency-assessment format. The professional development purpose was provided by the instructor, and students completed three of the course assessments: (a) top five initial self-competencies (Appendix A), (b) initial lean knowledge (Appendix F), and (c) pre-course survey (Appendix G). Lean project teams were assembled and evenly distributed based on

the students' initial lean knowledge assessment, pre-course survey and industry selection results in the second week. Each student team was furnished an industry mentor to provide guidance for their lean project work.

During the first five weeks, students experienced in-class simulations and other instructional activities involving lean tool applications including: 5S, value stream mapping, A3, standard work, JIT, SMED/quick changeover, and jidoka (Pascal, 2007). In weeks six and seven, project teams worked directly on their industry projects, and in week eight an "initial" online peer/team member assessment was completed. The instructor provided confidential peer feedback to each student the following week.

The student lean project teams spent the next five weeks predominantly out of the classroom working onsite with their industry mentors. In the 14th week, the final self- and peer- top five competency assessments were completed, along with the final lean knowledge assessment. The online software, WebCT, allowed students to complete all assessments and gave them ongoing access to their self-assessments. In order to maintain confidentiality, peer-assessment results were provided by the instructor. The last two weeks of the semester concluded with the completion of the post-course survey (Appendix G), and the structured self-reflection paper (Appendix B) wrapped up the semester. These were designed to capture students' perceptions of the 360-degree feedback assessment process and their professional development experience, respectively.

### **Data Analysis**

As a mixed methods study, both quantitative and qualitative data analysis was performed. Descriptive statistics were used in the analysis of the pre-course quantitative

data. All quantitative initial and final assessment average results (self, peer, and lean knowledge) were analyzed with SPSS 19 software using a simple inferential test, the paired *t*-test. This study was limited to a small sample size with 26 enrolled students and was further limited by completion rates (N=24, N=25) and by the fact it was a one semester course (16 weeks). The *t*-test is the optimal data analysis method to compare the means of paired samples and is recommended for small sample sizes ( $N < 30$ ). The qualitative data, obtained from the post-course survey and structured self-reflection paper, were analyzed using content analysis (Ratcliff, 2002). Content analysis was used as the approach for analyzing and interpreting the post-survey narrative data to bring meaning through identification of themes and patterns within student responses (Esterberg, 2002). The self-reflection paper analysis consisted of five rounds of coding with “theme” being used as the coding unit in primarily looking for expressions of an idea or concept through words and phrases (Minichiello, Aroni, Timewell, & Alexander, 1990). This was done to determine the frequency of a thematic response and to focus the analysis on questions 1, 2, 3, 4, 7, and 8 (Appendix B).

### **Dissertation Organization**

The compilation of data from this mixed methods case study revealed insight into the implementation of a competency-based learning and assessment process within a higher education environment. Competency-based assessments were the quantitative measurement method used to obtain quantitative evidence of student professional development. Additionally, a course survey and a structured self-reflection paper were the qualitative measurement methods used to obtain student perceptions of their professional development.



This study addressed a current gap in educational literature related to student professional development in higher education through competency-based learning and assessment. In order to address each of the different components of the study's data analysis, the researcher chose to create a journal article format dissertation. This strategic intent would allow the key components of this study to have a higher impact, contribute to current educational literature, and provide higher value for other researchers. This format contains chapters based on an overall introduction to the topic, three manuscripts prepared for submission to selected publications, a discussion of the study's findings, and recommendations for future research.

The following section, Chapter 2, is a manuscript prepared for submission to the *Journal of Technology Studies (JOTS)*. This article examines the implementation of competency-based learning and assessment as a measure of student professional development based on a quantitative methodology. It outlines the use of competency-based assessment in an industrial technology undergraduate course at Iowa State University. Based on degree program outcomes addressed and the instructor's experience with the industry-based, 360-degree competency assessment process, the top five workplace competencies were selected and their key actions assessed. Results indicate professional growth was detected, as measured by significant differences in the average and final assessed values. Additionally, this manuscript provides a foundational framework for further research studies in competency-based learning and assessment.

Chapter 3 is a manuscript prepared for submission to *The Journal of Technology, Management, and Applied Engineering (JTMAE)*. It seeks to understand student experiences utilizing a competency-based assessment tool used predominantly in industry, the 360-degree

feedback process. Pre- and post-course surveys captured both quantitative and qualitative student data. The pre-course survey established that students had no experience with the 360-degree assessment process. Post-course survey results captured students' perceptions, providing an understanding of their experiences and revealed benefits, difficulties, learning, fairness and accuracy, and impact on professional development.

Chapter 4 is a manuscript prepared for submission to the *Journal of Industrial Technology* and examines holistic student professional development using competency-based assessment through the lens of backward design (Wiggins & McTighe, 1998). Results show that holistic professional development was achieved as measured: (a) quantitatively through competency assessments, and (b) qualitatively through student perceptions captured in a structured self-reflection paper. Additionally, this study provides a framework for a holistic approach to student professional development and assessment.

## **Literature Review**

### **Student Development and Assessment**

Student development has been described as “the ways that a student grows, progresses, or increases his or her developmental capabilities as a result of enrollment in an institution of higher education” (Rodgers, 1990, p.27) and is about becoming a more complex individual (McEwen, 2005). The complementary theory used to explain and understand student development allows educators to “proactively identify and address student needs, design programs, develop policies, and create healthy environment that encourage positive growth in students” (Evans et al., 1998, p. 5). Existing student development theories are very much interrelated (Gardner, 2009).

Student development research literature has been synthesized (Knefelkamp, Widick, & Parker, 1978) into five clusters: psychosocial theories, cognitive developmental theories, maturity models, typology models, and person-environmental interaction models. Noting that they “did not find, nor could we create, the comprehensive model of student development” (p. xi), however, these have remained as separate lines of theorizing through much of the student development literature. Constructing a holistic theoretical perspective requires focusing on intersections rather than separate constructs. Kegan (1982), a pioneer in a holistic theoretical perspective, advocated focusing on the context rather than the polarities. Despite ongoing efforts, Abes, Jones, and McEwen (2007) noted, “Few models or theories exist to understand the holistic development of college students” (p. 16). Despite leaving us with pieces in the holistic development puzzle box, student development theory renders us unable to assemble a complete picture that represents holistic student development. It serves rather as a guide and reference point.

### **Holistic Student Development and Assessment**

A number of empirical studies of on-the-job excellence have clearly and repeatedly established that emotional competencies—communication, interpersonal skills, self-control, motivation, and so forth—are much more important for superior job performance than are cognitive and technical abilities (King & Skakoon, 2010). Boyatzis (2009) found that emotional, social, and cognitive intelligence competencies predict effectiveness in professional, management and leadership roles in many sectors of society and can be developed in adults.

The backward design process (Wiggins & McTighe, 1998) was utilized by Field, Freeman, and Dyrenfurth (2004) to advance their goal of holistic assessment of undergraduate students in an industrial technology program. This goes beyond the attainment of letter grades as the single outcomes achievement measure upon completion of an undergraduate degree program. They explored non-classroom-centered assessment methods and collected and analyzed preliminary data towards their goal attainment. As Field et al. (2004) stated:

the nature and assessment of education is changing significantly, the assessment trajectory is away from sole reliance on the traditional perspective of student grades, and a well-structured program should include assessment by a variety of methods and from a more holistic perspective than is often employed. (p. 78)

Wiggins and McTighe (1998) stated that:

it encourages us to think about a unit or course in terms of the collected assessment evident needed to document and validate that the desired learning has been achieved, so that the course is not just content to be covered by or a series of learning activities. (p. 12)

The backward design process description was condensed by Field et al. (2004) into three broad steps: (a) identify desired results, (b) determine acceptable evidence, and (c) plan learning experiences and instruction. This framework requires us to think about what student outcomes should be in a course, design the course to reflect this, and ensure that an appropriate assessment is in place to provide evidence of outcomes achievement. It is also a foundation for continuous course and curricular improvement.

### **Impetus for Change**

Accreditation has provided the impetus and opportunity to re-craft how we educate students (Brumm, Mickelson, et al., 2006). “External constituents are demanding not only that departments say they are doing good things and not only that they measure how hard they are trying, but also that they measure outcomes” (Walvoord, Carey, Smith, Soled, Way, & Zorn, 2000). ATMAE’s *2011 Outcomes Assessment Accreditation Handbook* gave this as the objective statement of accreditation: “To ensure that programs in Technology, Management, and Applied Engineering that are accredited meet established standards and that outcome measures are used to continuously improve programs” (p. 3). Faculty are challenged to look ahead to anticipate emerging skills or a change in the emphasis on certain skills that could impact the preparedness of engineers and technology graduates for employability in the knowledge-intensive workplace.

Successful transition from academia to the twenty-first century workplace requires that college graduates acquire technical skills in their field as well as skills for interacting effectively with people (Hayward & Blackmer, 2007). Because most college-aged students are entering adulthood, the attitudes, interests, values, and character development that underlie their behaviors may not be at a professional level (Hayward et al., 1999). Professional identity development is gained through the process of professional socialization in which an individual learns to adopt the values, skills, attitudes, norms, and knowledge needed for membership in a given society, group, or organization (Merton, 1957).

## **Professional Development**

Professional development (PD) can be defined in diverse ways and can take on many forms. Typical levels likely to be encountered are: (a) individual, (b) group or program, (c) departmental, (d) divisional, and (e) professional associations. In the 1970s, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) created definitions in which three educationally-focused terms were used to descriptively summarize the types of PD—formal, nonformal, and informal education (Schwartz & Bryan, 1998), with formal education being the traditional classroom education. Nonformal education is “any organized, systematic, educational activity, carried on outside the framework of the formal system, to provide selected types of learning to a particular subgroup in the population” (Coombs, 1985, p. 23). Informal education is learning by association and affiliation, specifically, “the life-long process by which every person acquires and accumulates knowledge, skills, attitudes, and insights from daily experiences and exposure to the environment” (Bhola, 1983, p. 47).

We may recall that Odysseus from Homer’s *The Odyssey* entrusted his son’s education to the person he trusted with his own life, his friend, Mentor. Today, a mentor remains someone referred to as a person who is trusted, forming a relationship with the mentee of guidance and advice, and one of many activities clustered under the broader term, professional development (Schwartz & Bryan, 1998). Over the last 20 years, the central finding of a plethora of mentoring research has been the association between the presence of a mentor and career success (Allen & Eby, 2007; Kram & Ragins, 2007). A study using a career capital (human, agentic, and developmental network) framework found that mentoring

added value above and beyond the other forms of career capital in predicting promotions and advancement expectations (Singh, Ragins, & Tharenou, 2009), and “although mentoring mattered for career success, it represented just a portion of a constellation of career resources that are embedded within individuals and their relationships” (p. 56).

One benefit for all professionals is the transformative value of professional development (Schwartz & Bryan, 1998). Whether it is achieved individually, in groups, in formal classes, or in a workshop, the process of renewal and growth essential for human development is more likely to be found in professional development activities than in any other activity.

### **Competencies**

The definition of workplace competencies is the application of knowledge, skills, attitudes and values, and behaviors (Ewell, 1984); these competencies are directly measurable through actions or demonstrations of the existence of those competencies in the individual. Thus, the opportunity to gain practice in the application of competencies and focused reflection in a workplace connects with experiential learning, which is defined as “the process whereby knowledge is created through the transformation of experience and knowledge results from the combination of grasping and transforming experience” (Kolb, 1984, p. 41). Recent studies have confirmed that the experiential workplace was one of the settings most likely—and the traditional classroom the least likely—to develop and demonstrate these competencies (Brumm, Hanneman, et al., 2006). Competency models can be used to guide individual professional development and to develop curricula that meet the needs of employers (Rothwell & Wellins, 2004).

## **Competency-Based Learning**

Building a bridge between the educational paradigm that depends on traditional credit hour measures of student achievement and the learning revolution can be found in competency-based approaches (R. Voorhees, 2001). Competencies are crucial for students before, during, and after attending postsecondary institutions (National Center for Education Statistics [NCES], 2002). Competency-based learning (CBL) models rely on both the judgment of those external to the learning process and on measurable assessment (R. Voorhees, 2001). A conceptual model of learning based on competencies does not work solely at the level of skill, abilities, and knowledge, but seeks also to formulate curriculum and assessment at the competency level which embodies integration of skills, abilities, and knowledge needed to become part of the disciplinary community of practice (Jones, 2001).

Competencies have a stronger impact on student learning when they are linked to and embedded within specific courses and across the curriculum (DDI, 2004). Competencies provide students with a clear map and the navigational tools needed to move expeditiously toward their goals (R. Voorhees, 2001). The advantage to CBL is that competencies are transparent; that is, all participants in the learning process understand the learning goals and outcomes. Competency expectations have increased significantly across all sectors of the economy, and the abilities employers expect new college graduates to demonstrate the first day on the job have been ratcheted up to an “über” level (Hanneman & Gardner, 2010). Research is needed to examine the integration of academic and experiential learning (Hayward & Blackmer, 2007).



## **Competency-Based Assessment**

Since the concept of competency-based human resource management was first proposed in the 1970s as a critical differentiator of performance (Boyatzis, 2009), it has become a predominant workplace reality, commonly used as an organizational development tool for the learner (McCarthy & Garavan, 2001). Built upon earlier work on skills, abilities, and cognitive intelligence (Campbell, Dunnette, Lawler, & Weick, 1970), it became a tool for understanding the talent and capability of human capital within an organization. Assessment ratings obtained from self and others constitute its core (Tornow & London, 1998). The benefit of collecting data of this kind is that the person gets to see a panorama of perceptions rather than just self-perception, thus affording a more complete picture.

The fundamental premise is that data gathered from multiple perspectives are more comprehensive and objective than data gathered from only one source (Dyer, 2001). Many organizations use some form of the 360-degree feedback assessment inventory process (Nowack, 1993), and it is implemented in a variety of ways. Self-ratings are the first step to development for the feedback recipient, and value lies in the diversity of information it provides to the feedback recipient and how it is interpreted. It can be perceived as a positive self-development platform in stark contrast to the traditional top-downward evaluation process. Under ideal circumstances, it is used as an assessment for personal development rather than evaluation (Tornow & London, 1998). Widespread in many organizations around the world (Brutus et al., 2006), this process is reportedly used by 90% of Fortune 500 companies in the U.S. (Carruthers, 2003). The popularity of this practice has stimulated much research enthusiasm in the academic field (Dai, De Meuse, & Peterson, 2010).

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## **CHAPTER 2. STUDENT PROFESSIONAL DEVELOPMENT: COMPETENCY-BASED LEARNING AND ASSESSMENT**

A manuscript prepared for submission to the *Journal of Technology Studies*

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### **Abstract**

This case study examines the implementation of competency-based learning (CBL) and assessment as a measure of student professional development. Students enrolled in an industrial technology undergraduate course at a Midwestern University participated in this study. Based on the degree program outcomes, the “top five” course competencies were identified, and their key action items assessed using an industry-based, 360-degree assessment process. Significant differences in the average initial and final assessed values were used to determine professional development gains. Findings showed that self-assessed professional gains were achieved, self-assessed results were higher than peer, and overall peer assessments indicated aggregate gains in professional development. This case study provides a foundational framework for further research studies in competency-based learning and assessment.

### **Background**

Because most college-aged students are entering adulthood, the attitudes, interests, values, and character development that underlie their behaviors may not be at a professional level (Hayward, Noonan, & Shain, 1999). Student development has been described as “the ways that a student grows, progresses, or increases his or her developmental capabilities as a result of enrollment in an institution of higher education” (Rodgers, 1990, p. 27) and is about becoming a more complex individual (McEwen, 2005). The complementary theory used to



explain and understand student development allows educators to “proactively identify and address student needs, design programs, develop policies, and create healthy environments that encourage positive growth in students” (Evans, Forney, & Guido-DiBrito, 1998, p. 5).

Existing student development theories are very much interrelated (Gardner, 2009).

Psychosocial development theories are concerned with the content of development including growth or change related to how students view themselves and their abilities, the relationships they have with others in their lives, and the future direction of their lives (Chickering & Reisser, 1993). This encompasses adult development and career development (McEwen, 2005).

Competencies are the result of integrative learning experiences in which skills, abilities, and knowledge interact to form learning bundles that have a currency related to the task for which they are assembled; interest in competencies is accelerating throughout the world (R. Voorhees, 2001). Until recently, competencies have been discussed from the demand side of employment with consideration primarily given to the needs of employers. Competency models can be used by the supply side of the labor market as well, such as a learner or student, incumbent worker, or hopeful and expectant new employees applying for a position to achieve job stability (Ennis, 2008). Competency-based models enjoy an obvious connection to aspirational student learning statements, because they shift the focus from instructional delivery to student performance (A. Voorhees, 2001). Competency-based learning (CBL) involves redefining program, classroom, and experiential education objectives as competencies or skills and focusing coursework on competency development (Brumm, Mickelson, Steward, & Kaleita, 2006).

Postsecondary education has become progressively responsive to the needs of business and industry, where learning is closely tied to competencies and performance-based assessment of those competencies (Gardner, 2009). Building a bridge between the educational paradigm that depends on traditional credit hour measures of student achievement and the learning revolution can be found in competency-based approaches (R. Voorhees, 2001). These competencies are crucial for students before, during, and after attending postsecondary institutions (National Center for Education Statistics [NCES], 2002). In a 2002 report, the U.S. National Postsecondary Education Cooperative Working Group on Competency-Based Initiatives determined three reasons why it is important to implement competency-based initiatives in colleges and universities:

One main reason is that specific articulations of competencies inform and guide the basis of subsequent assessments at the course, program, and institutional levels. Secondly, specific competencies help faculty and students across campus, as well as other stakeholders such as employers and policymakers, to have a common understanding about the specific skills and knowledge that undergraduates should master as a result of their learning experiences. Assuming that faculty use a formal process to get feedback about what the competencies should be, then stakeholders are more likely to accept and value them. Third, specific competencies provide directions for designing learning experiences and assignments that will help students gain practice in using and applying these competencies in different contexts. (NCES, 2002, p. vii)

The definition of workplace competencies is the application of knowledge, skills, attitudes and values, and behaviors (Ewell, 1984). These competencies are directly measurable through actions or demonstrations of the existence of those competencies in the individual. Thus the opportunity to gain practice in the application of competencies and focused reflection in a workplace connects with experiential learning, which is defined as “the process whereby knowledge is created through the transformation of experience and knowledge results from the combination of grasping and transforming experience” (Kolb, 1984, p. 41).

Since the 1990s, competencies have become code words for the human resources and strategic management practices of recruiting, selecting, placing, leading, and training employees and evaluating employee performance. Competency-based assessment and feedback has become a predominant workplace reality which is commonly used as an organizational development tool for the learner (McCarthy & Garavan, 2001). A competency-based assessment tool popularized in the 1980s, mostly as an executive development tool that gained currency in the 1990s, is the multi-rater or 360-degree feedback process (McCarthy & Garavan, 2001). The fundamental premise is that data gathered from multiple perspectives are more comprehensive and objective than data gathered from only one source (Dyer, 2001).

Many organizations use some form of the 360-feedback assessment process (Nowack, 1993), and it is implemented in a variety of ways. Ratings from self and others, however, constitute the core of the 360-degree feedback process (Tornow & London, 1998). Self-ratings are the first step to development for the feedback recipient. The value lies in the

diversity of information it provides to the feedback recipient and how it is interpreted. It can be perceived as a positive self-development platform, in stark contrast to traditional top-downward evaluation process. Under ideal circumstances, it is used as an assessment for personal development rather than evaluation (Tornow & London, 1998). Widespread in many organizations around the world (Brutus et al., 2006), this process is reportedly used by 90% of Fortune 500 companies in the U.S. (Carruthers, 2003). The popularity of this practice has stimulated much research enthusiasm in the academic field (Dai, De Meuse, & Peterson, 2010).

### **Incentivizing Competency-Based Learning**

Institutional accountability, articulation and student transfer issues, and workplace market alignment have become critical drivers that can provide the impetus for institutions to shift to competency-based models (A. Voorhees, 2001). Increasingly, accreditation requirements challenge faculty to look ahead to anticipate emerging skills or a change in the emphasis on certain skills that could impact the preparedness of engineers and technology graduates for employability in the knowledge-intensive workplace. Competencies provide students with a clear map and the navigational tools needed to move expeditiously toward their goals (R. Voorhees, 2001). The advantage of competency-based learning (CBL) is that competencies are transparent; that is, all participants in the learning process understand the learning goals and outcomes. Competency expectations have increased significantly across all sectors of the economy, and the abilities employers expect new college graduates to demonstrate the first day on the job have been ratcheted up to an 'über level' (Hanneman & Gardner, 2010).

## **The Foundation**

### **Competency-Based Approach to Accreditation**

Midwestern University's unique approach to accreditation requirements was to address them through development of workplace competencies (Brumm, Mickelson, et al., 2006). Identification of key industry employer needs drove this rationale: "employers of the graduates of our program are increasingly focusing on workplace competencies in their hiring practices, and student development of competencies is, therefore, critical to career success after graduation" (p. 1163). Through collaboration with Development Dimensions International, Inc. (DDI), a global provider of competency-based performance management tools and services, 14 unique workplace competencies were developed. Seven were identified as "core" competencies, which were regularly mentioned by employers (<http://learn.ae.iastate.edu/Competencydefinitions.pdf>). These 14 competencies were mapped directly to degree program outcomes. Each competency was defined clearly, concisely, and independently. Specific to each definition, a set of observable and measurable key actions was developed. By closely tying competencies with performance-based assessment of those competencies, a bridge is built between traditional measures of student achievement and competency-based approaches (R. Voorhees, 2001).

### **Course Connectivity**

Competency-based models rely on both the judgment of those external to the learning process and on measurable assessment (R. Voorhees, 2001). A conceptual model of learning based on competencies does not work solely at the level of skill, abilities, and knowledge but seeks to formulate curriculum and assessment at the competency level; this embodies

integration of skills, abilities, and knowledge needed to become part of the disciplinary community of practice (Jones, 2001). Competencies have a stronger impact on student learning when they are linked to and embedded within specific courses and across the curriculum (DDI, 2004).

A lean/cellular manufacturing course for senior-level undergraduate students provided the opportunity to design a CBL experience. Based on the instructor's industry background, professional development based on competency assessment was considered critical to prepare students for success in the workplace environment. The intent of the course design was to provide students the opportunity to "step through the looking glass" and understand the role competencies and competency assessment play in professional/career development. In this pursuit, all coursework and activities developed were focused on competency development. Northwestern University's Industrial Technology assessment plan already contained competency-based learning tools that easily integrated into the course: 14 workplace competencies and a competency assessment format. Based on previous stakeholder assessment feedback, all 14 workplace competencies would not be utilized for the 360-degree process. Thus a review of the course "core" competency frequency, coupled with the instructor's 360-degree assessment industry experience, was used to identify the top five course competencies: (a) analysis & judgment, (b) communication, (c) initiative, (d) continuous learning, and (e) teamwork. These top five competencies were the basis for the implementation of the 360-degree assessment process.

### **Purpose of the Study**

This case study examines implementation of CBL and a 360-degree feedback assessment process as a measure of student professional development. Specifically, the primary purpose of this study was to measure student professional development utilizing an industry-based, 360-degree competency assessment process. An additional goal was the development of a framework for CBL and assessment that can be utilized in other higher education settings.

### **Method**

Twenty-six students enrolled in a lean/cellular manufacturing course in the Industrial Technology program at Midwestern University participated in this study. The top competencies were used for initial and final assessments, of both self and peers, during the semester. Key actions associated with each competency were assessed utilizing the department's Likert-scale format. These assessment ratings were based on how often a key action was performed, ranging from 1 to 5 with 1=never or almost never, 2=seldom, 3=sometimes, 4=often, and 5=always or almost always.

The top five competencies, along with the assessment process, were introduced to students the first day of the course. The students completed an online initial competency self-assessment the first week of class focused on these five competencies. During the second week of class, industry teams were formed, and industry mentors were assigned for the semester's lean manufacturing project. During the first five weeks, students experienced in-class simulations and other instructional activities involving lean tool applications including: 5S, value stream mapping, A3, standard work, JIT, and jidoka (Pascal, 2007). At

mid-term, student teams presented their lean project progress/status overview, and completed an “initial” online peer/team member assessment. The instructor provided confidential peer feedback to each student the following week. The student lean project teams spent the next five weeks predominantly out of the classroom working onsite with their industry mentors. During the 14th week, final self- and peer-competency assessments were completed. The instructor provided confidential results for peer assessments the following week.

### **Results**

All initial and final competency assessments were analyzed with SPSS 19 software using paired sample *t*-testing. The *t*-test is the optimal data analysis method used to compare the means of paired samples and is recommended for small sample sizes ( $N < 30$ ). The self- and peer-competency assessments were assigned to all students. One student didn't complete the initial, and another didn't complete the final self-assessment. These were not included in the data analysis ( $N=24$ ). The top five competencies' definitions are shown in Table 1. The competencies' key action items, shown in Table 2, were assessed and an average value reported.

#### **Self-Assessment**

The average results for key action items within each of the top five competencies, based on the initial and final self-assessments, are shown in Figure 1. Significant differences ( $p < .05$ ) are indicated with an asterisk (\*). Overall, an increase in final over the initial assessed average value was found in at least one key action item (\*) for each of the five top competencies and serves as an indicator of self-assessed professional development.



### Self- vs. Peer-Assessments

A comparison of the results for the key actions between all self- and peer-assessments is shown in Figures 2 and 3, respectively. In the initial assessment, significant differences (\*) were detected in specific key action items in two of the five competencies (analysis and judgment, and teamwork), between self and peer results. In all cases, the self-assessed average results were higher than peer-assessed average results. In the final assessment results, significant differences in specific key action item averages were also found for two of the five competencies (initial and teamwork). Once again, self-assessed average values were higher than peer-assessed average values. Results indicate that for both the initial and final assessments, KA2 in the teamwork competency was the significant difference commonality. The correlations found in this study between self and peer for the initial assessment ranged from  $-0.429$  to  $0.534$  and ranged from  $-0.394$  to  $0.354$  for the final assessment.

Table 1

#### *"Top Five" Course Competencies and Definitions*

Competency	Definitions
Analysis and Judgment	Identifying and understanding issues, problems and opportunities; developing the relevant criteria and comparing data from different sources to draw conclusions: using effective approaches for choosing courses of action or developing appropriate solutions; taking actions that are consistent with available facts, constraints, and probably consequences
Communication	Clearly conveying information and ideas through a variety of media to individuals or groups in a manner that engages the audience and helps them understand and retain the message.
Initiative	Taking prompt action to accomplish objectives; taking action to achieve goals beyond what is required; being proactive.
Continuous Learning	Actively identifying new areas for learning; regularly creating and taking advantage of learning opportunities: using newly gained knowledge and skill on the job, and learning through applications.
Teamwork	Effectively participating as a member of a team to move the team toward completion of goals.

Table 2

*Course Competencies and Key Actions Assessed*

Competency	Key Actions
Analysis & Judgment	KA1 Identifies issues, problems and opportunities.
	KA2 Gathers information.
	KA3 Interprets information.
	KA4 Generates alternatives.
	KA5 Chooses appropriate action.
	KA6 Commits to action.
	KA7 Involves others.
	KA8 Values diversity.
Communication	KA1 Organizes the communication.
	KA2 Maintains audience attention.
	KA3 Adjusts to audience.
	KA4 Ensures understanding.
	KA5 Adheres to accepted conventions.
	KA6 Comprehends communication from others.
Initiative	KA1 Goes above and beyond.
	KA2 Responds quickly.
	KA3 Takes independent action.
Continuous Learning	KA1 Targets learning needs.
	KA2 Seeks learning activities.
	KA3 Maximizes learning.
	KA4 Applies knowledge or skill.
	KA5 Takes risks in learning.
Teamwork	KA1 Facilitates goal accomplishment.
	KA2 Informs others on team.
	KA3 Involves others.
	KA4 Models commitment.
Engineering/Technical Knowledge	KA1 Knowledge of mathematics.
	KA2 Knowledge of science.
	KA3 Knowledge of experimental analysis.
	KA4 Knowledge of current engineering/technology tools*
	KA5 Knowledge of technology.

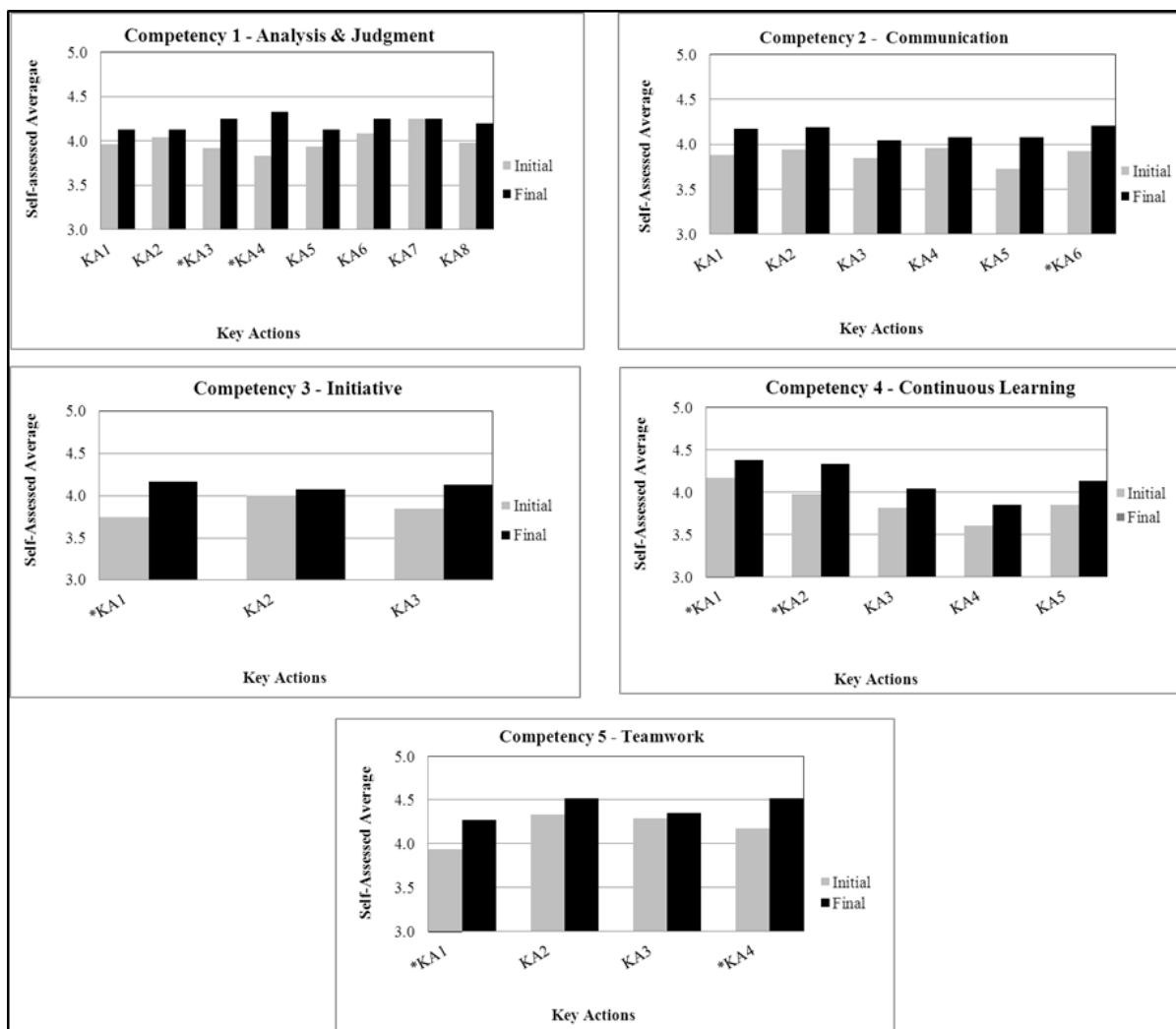


Figure 1. Self-assessed average ranking of key actions. (N=24). \*p<.05.

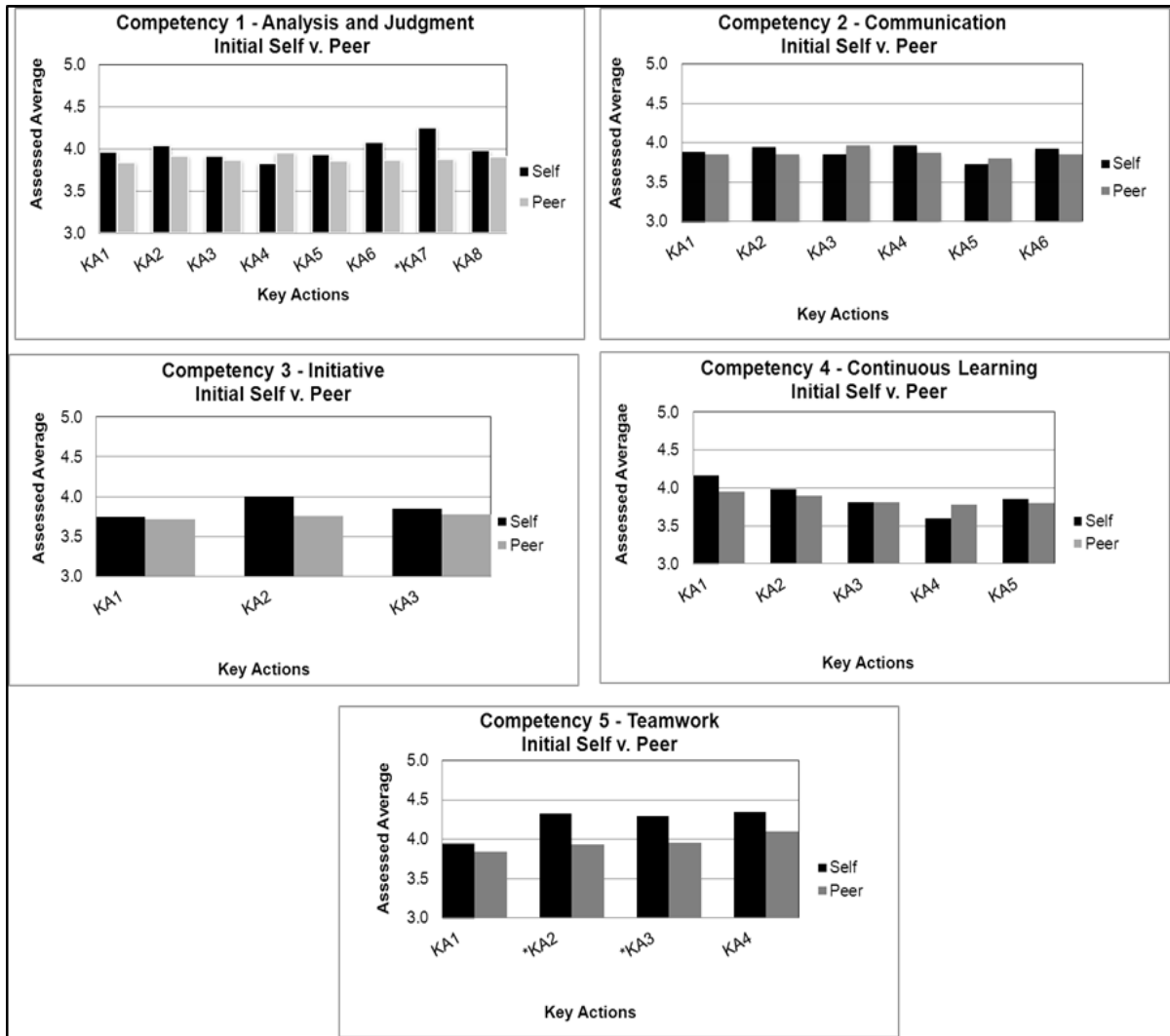


Figure 2. Initial self- vs. peer-assessed average ranking for key actions. (N=24). \*p<05.

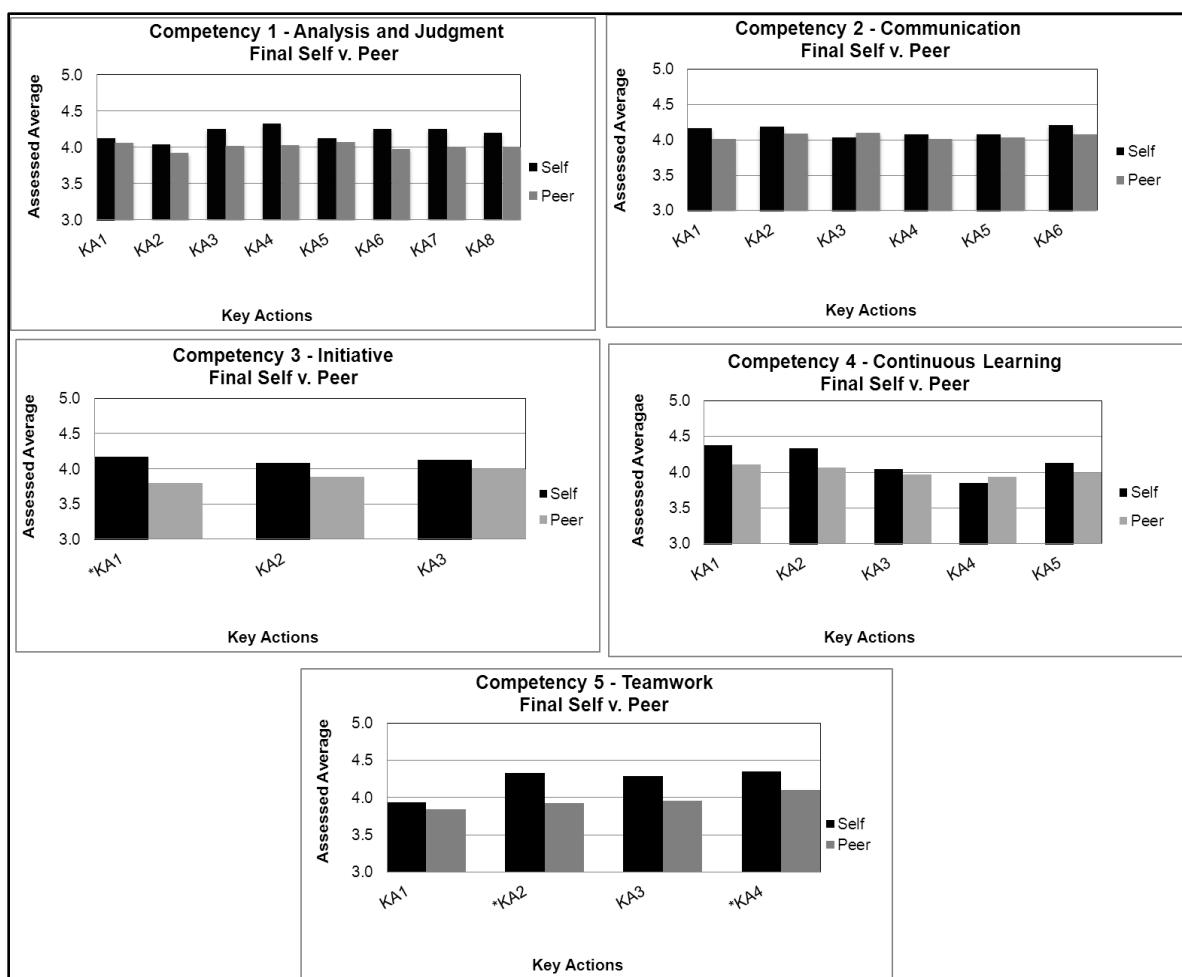


Figure 3. Final self-vs. peer assessed average rankings for key actions (N=24) \* $p < .05$ .

### Peer-Assessments

The average results for the key action items contained within each of the top five competencies for the initial and final peer-assessments are shown in Figure 4, with significant differences ( $p < .05$ ) indicated with an asterisk (\*). Overall, in four of the five competencies, significant differences (\*) in the average assessed value were found in at least one key action item. These key action items experienced an increased average value between the initial and final average assessed value. As a peer-assessment/student aggregate, this serves as a measure of professional growth over the semester.

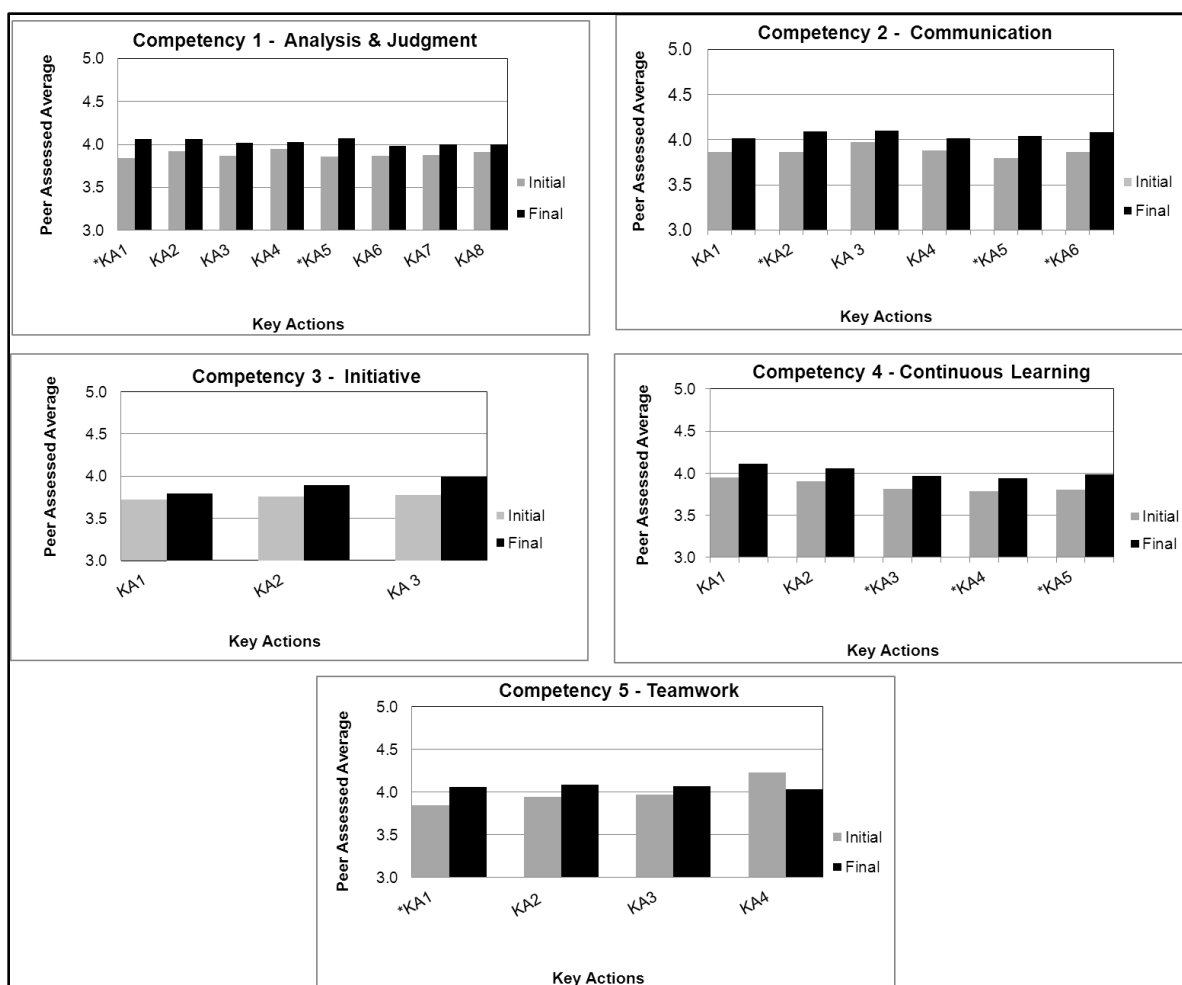


Figure 4. Peer assessed average ranking for key actions (N=24) \*p<.05.

## Discussion and Conclusions

Utilizing the department's competency assessment format, a 360-degree assessment process was implemented into an undergraduate course. This allowed key action items associated with the top five course competencies to be assessed. The self-assessment results showed higher final average assessed values in at least one key action item for each of the five competencies. Not commonalities in the key action items between the initial and final self-assessment results were observed. The higher final average values indicated

self-assessed professional gains were achieved (Figure 1). The comparison of self v. peer results showed two commonalities:

1. higher average values were all detected in the self-assessments, and
2. KA2 within the teamwork competency showed higher self-assessed values in both the initial and final assessments (Figures 2 and 3).

The overall peer assessment results showed higher average final results in at least one key action item for each of the five course competencies (Figure 4).

The results are indicative of the complex task of comparing self-perception to others, which involves social information processing and interpersonal insight (London, 1994). As Tornow (1993) found, self-assessments are, on average, higher than others, including peers. Psychological mechanisms related to how we operate in social environments may become impediments to accurate self-assessment. Although peer ratings often tend to be far lower than self-ratings, they are fast becoming one of the most valued sources of appraisal as opposed to the usual supervisor ratings (McCarthy & Garavan, 2001). According to Jones and Bearley (1996), this is a direct consequence of an organization's increased focus on self-managed work teams and flatter structures. Peer feedback provides insight into how one behaves in team situations as well as the influencing behaviors that serve to gain commitments when no direct authority can be exercised (Lepsinger & Lucia, 1997).

Classroom research has demonstrated reasonable agreement between self and peer ratings (McGourty, Dominick, Besterfield-Sacre, Shuman, & Wolfe, 2000), and correlations ranging from 0.12 to 0.39 (Reilly, 1996) have been reported. Correlation results for this study are possibly due to the study's limitations. Researchers have suggested that low

agreement may be due to real behavioral or skill differences in the target student as perceived by sources with different perspectives such as fellow students (Tornow, 1993).

This case study was limited to the assessment of the top five workplace competencies determined for one course, one semester (16 weeks), and small sample size (N=24). Self- and peer-evaluations are not entirely free of bias, which was not addressed in this study. A great deal of research has been directed at the relationship between individual characteristics and rating tendencies; research has focused on characteristics of the raters, the ratee, or both. In this case study, these characteristics were not the central focus. Rather, the focus was to determine if competency assessment can be implemented into the classroom to measure and detect evidence of student professional development. Implementation of the competency-based 360-degree assessment process to obtain quantitative results allowed us to measure professional development.

The value of competency assessment as a measure both in this study and in industry is that it provides a stepping stone for professional self-development. This study provided a framework for competency-based learning and assessment that can be utilized in a higher education environment. Despite its limitations, the implications for future research are evident. More studies are needed to collect and analyze data regarding competency-based learning and the use of multi-source/360-degree assessments to measure student professional development in an educational setting. It gives us an inkling of the possibilities and impact that future studies can provide, not only to improve our approach to student assessment, but in curricular improvement efforts that better prepare students for their professional endeavors.



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### **CHAPTER 3. PROFESSIONAL DEVELOPMENT AND ASSESSMENT: STUDENT PERCEPTIONS OF THE 360-DEGREE FEEDBACK PROCESS**

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#### **Abstract**

This study seeks to understand student experiences utilizing a competency-based assessment tool, the 360-degree feedback process. An undergraduate course within a Midwestern University's industrial technology program provided the opportunity to implement a 360-degree assessment process and capture student perceptions. The course was designed to provide students with the realities of today's employee competency development and assessment processes. Pre- and post-course surveys were utilized to capture quantitative and qualitative student data. The pre-course survey results revealed that students had no experience with the 360-degree assessment process. The post- survey results captured the students' perceptions of the assessment process experience. This provided an understanding of the students' experiences and revealed benefits, difficulties, learning, fairness and accuracy, and impact on professional development.

#### **Introduction**

Psychosocial student development theories predominantly emphasize the intersections between how we see ourselves and relationships with others (Baxter Magolda, 2009). In viewing the workplace through the concept of connectivity, individuals are connected in that they derive meaning with and through other people about what is expected and how well they are doing (Tornow & London, 1998). Individuals' self-awareness is

heightened when receiving feedback from others and this, combined with a sense of self, can be felt as the gap between self-perceptions and the perceptions of others. An industry –based competency tool, the 360-degree feedback process, can be used to identify and address this gap. Individuals can constantly adjust and match their behaviors to a goal or standard and use the information to diagnose their weaknesses and determine directions for behavior change. Recipients could potentially compare feedback received to standards, as posited by control theory (Carver & Scheier, 1982) and feedback intervention theory (Kluger & DeNisi, 1996). Under ideal circumstances, it is used as an assessment for personal development rather than evaluation (Tornow & London, 1998).

The 360-degree feedback process is widespread in many organizations around the world (Brutus et al., 2006). According to Human Resource Consultant William M. Mercer, 40% of American companies used 360-degree feedback in 1995; by 2000, this number had jumped to 65% (Alexander, 2006). In 2002, 90% of Fortune 500 companies were reportedly using a 360-degree performance review process in the U.S. (Carruthers, 2003). The popularity of this practice has stimulated much research enthusiasm in the academic field (Dai, De Meuse, & Peterson, 2010).

## **Background**

### **Competencies and Professional Development**

Professional development (PD) has been identified with the process of maturing and evolving as a professional and has become an integral element of professional practice in various fields (Ducheny, Alletzhauser, Crandell, & Schneider, 1997). The mechanism for organizing PD is through professional identity and is gained through the process of

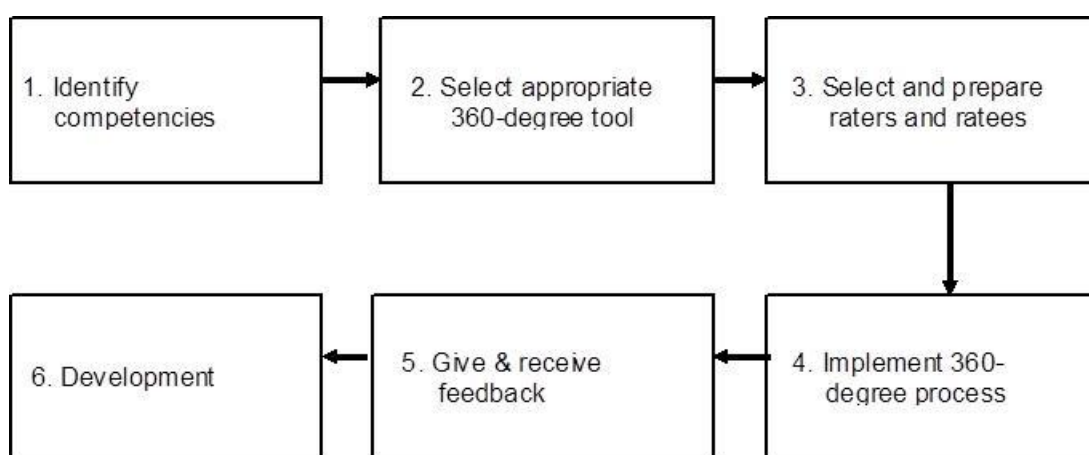
professional socialization in which an individual learns to adopt the values, skills, attitudes, norms, and knowledge needed for membership in a given society, group, or organization (Merton, 1957). Competency models can be used to guide individual professional development, as well as assist in developing curricula that meet the needs of employers (Rothwell & Wellins, 2004). Competency-based learning (CBL) involves redefining program, classroom, and experiential education objectives as competencies or skills and focusing coursework on competency development (Brumm, Mickelson, Steward, & Kaleita, 2006). Competencies have a stronger impact on student learning when they are linked to and embedded within specific courses and across the curriculum (Jones, 2001). Competencies are crucial for students before, during, and after their attendance at postsecondary institutions (National Center for Education Statistics, 2002).

### **Competency-Based Assessment**

Assessment has gained much attention in academia and, in particular, the nexus between assessments and the teaching and learning process (Atkins, 1995). Competencies have become code words for the human resources and strategic management practices of recruiting, selecting, placing, leading, and training employees and evaluating employee performance. Competency-based assessment and feedback is a predominant workplace reality, commonly used as an organizational development tool for the learner (McCarthy & Garavan, 2001). The 360-degree feedback/assessment process used today stems from several traditions in industrial and organizational psychology (Tornow & London, 1998). One is the employee attitude survey (Nadler, 1977), and another is the performance appraisal. The dynamic nature of an ever-changing work environment has added to the popularity of this

assessment tool—job complexity requiring multiple perspectives on employee performance, organizational restructuring placing the developmental burden on the employee, and the lack of structured career paths (Tornow & London, 1998).

This process can be conceptualized as six phases depicted in Figure 1 (Cooper & Schmitt, 1995; Garavan, Morley, & Flynn, 1997; Huggett, 1998; Jansen & Vloeberghs, 1999; Theron, 2000; Van der Heijden & Nijhof, 2005).



*Figure 1.* Conceptualization of 360-degree feedback process

The four common feedback sources utilized in a 360-feedback process include: self, peers, managers, and subordinates (McCarthy & Garavan, 2001). Self-ratings are the first development step for the feedback recipient, which involves rating his/her own performance (Lepsinger & Lucia, 1997). Commonly referred to as the lenient ratings (McCarthy & Garavan, 2001), these self-ratings are often more inflated than ratings from other sources (Valle & Bozeman, 2002). Peer ratings also afford raters an opportunity to observe ratees' performance and have a higher reliability as well as constructive and predictive validity (Valle & Bozeman, 2002). Peer ratings are fast becoming one of the most valued sources of



appraisal as opposed to the usual supervisor ratings (McCarthy & Garavan, 2001).

According to Jones and Bearley (1996), this is a direct consequence of an organization's increased focus on self-managed work teams and flatter structures.

Peer feedback provides insight into how one behaves in team situations as well as the influencing behaviors that serve to gain commitments when no direct authority can be exercised (Lepsinger & Lucia, 1997). There are benefits and challenges with peer ratings; to counter some of these, Garavan et al. (1997) suggest that peers who are selected as raters consist of those who interact frequently with the employee/feedback recipient. These raters are likely to provide constructive feedback as opposed to only positive or negative feedback. The value of the 360-degree feedback process lies in the diversity of information it provides to the feedback recipient and how that information is interpreted. The feedback process promotes connectivity for individuals as they derive meaning with and through other people about what is expected of them and how well they are doing (Tornow & London, 1998).

### **Learning and Assessment**

Since students tend to organize their learning based on cues from assessment, there are several ways in which assessment can promote learning (Brown, Race, & Rust, 1997; Gibbs, 1999). Assessment processes not only provide valuable data on learning outcomes, but also have an impact on learning itself (McGourty, Dominick, Besterfield-Sacre, Shuman, & Wolfe, 2000). Research exploring assessment that enhances student learning has demonstrated the importance of student participation in the assessment process (Vu & Dall'Alba, 2007). Through direct participation, students are able to reflect on their experience and monitor their learning (Reynolds & Trehan, 2000). Self-assessment ratings

require self-reflection and introspection, as the individual process of looking inward, reflecting and evaluating where one stands in relation to feedback (Tornow & London, 1998). Peer assessment helps students to diversify their own approaches and strategies in undertaking a learning task and can deepen understanding about high- or low-quality performance (Gibbs, 1999). Another benefit of peer assessment is that it can be an appropriate arena for independent learning.

Peer assessment requires students to make independent judgments and provide comments on the work of their peers (Brown & Knight, 1994). This socially and intellectually challenging activity can enable students to develop capacities appropriate to professional and other contexts (Vu & Dall'Alba, 2007). Additionally, peer assessment can enhance collaboration between teacher and students (Leach, Neutze, & Zepke, 2001). Peer assessments have been found to be valid and reliable (Landy & Farr, 1983), however, this doesn't mean they are free from biases (Fox, Ben-Nahum, & Yinon, 1989). Given the associated benefits and challenges, further research is needed into the practice of peer assessment (Reynolds & Trehan, 2000). Such research can throw light on the intellectual and social processes that peer assessment entails, which impact upon students' experience of peer assessment and its outcomes (Vu & Dall'Alba, 2007).

## **Methods**

### **Participants and Data**

Twenty-six students in a senior-level undergraduate industrial technology course participated in the 360-degree assessment process as conceptualized in Figure 1. Two assessment tools, integral to the 360-degree process, already existed with the department: 14

workplace competencies and an assessment format (Brumm , Mickelson, et al., 2006). The top five course competencies were identified and their key actions assessed (Baughman, 2012). On the first day of class students completed a pre-course survey (as shown in Figure 2), were introduced to the top five competencies, and prepared for the 360-degree assessment process. This included an in-depth review of competencies and key actions, as well as an outline of the assessment process. The timeline for all self- and peer-assessments, provided in the syllabus, was discussed and highlighted. Additionally, the purpose of both the 360-degree assessments was also discussed. The instructor related professional experiences with employee competency-based development and assessment and the role of the 360-degree process. It was evident during class discussions that students were familiar and comfortable with department’s 14 workplace competencies and assessment format. These tools are an integral part of the department’s degree program (Brumm, Mickelson, et. al, 2006).

<b><u>Pre-Course Survey</u></b>		
1. Intern Experience?	Yes	No
2. Manufacturing Experience?	Yes	No
3. a. Have you used 360-feedback before?	Yes	No
b. If yes, please describe your experience, specify context( internship, etc.)		

*Figure 2.* Pre-course survey

The 360-degree feedback process was initiated at the end of the first class with the completion of the initial competency self-assessment (Baughman, 2012). A post-course survey, shown in Figure 3, was completed at the end of the semester. An online tool, WebCT, was used to complete all assessments and surveys during the semester.

### **Post-Course Survey**

1. Prepare a one paragraph description of your 360-degree experience this semester.
2. What were the benefits of the 360-degree feedback process?
3. What did you find difficult about the 360-degree feedback process?
4. What did you learn from the 360-degree feedback process?
5. Do you think that you assessed your peers fairly and accurately? Describe why or why not.
6. Describe how the 360-feedback process impacted your professional development.

*Figure 3.* Post-course survey

### **Analysis**

Both quantitative and qualitative methods were used in the analysis of this mixed methods study. Descriptive statistics were used to summarize the quantitative data from the pre-course survey. Question 3b was answered by one student, and results are provided in the next section. Content analysis was the approach used for analyzing and interpreting the post-survey narrative data (Ratcliff, 2002). The first step in this analysis was to download post-survey student responses and organize them in a spreadsheet format. Initially, categories were placed in columns; the rows contained student names and corresponding answers. Prior to data analysis, in order to reduce bias, the student name column was removed. The focus of the analysis was to bring meaning through identification of themes and patterns within student responses to the six categorized, open questions (Esterberg, 2002).

### **Results**

As the pre-course survey results revealed in Table 1, 96% of the students responded and indicated they had no 360-degree feedback/assessment process experience. One student experienced an internship supervisory assessment, or upward assessment, not 360-degree

feedback. Thus it was concluded that students had no 360-degree process experience prior to the course.

Perceptions of the 360-degree assessment process were extracted from student responses to the post-survey questions (Figure 3). The response rate for the post-course survey was 73% (19/26).

Table 1

*Descriptive Statistics Pre-Course Survey Results (N=25)\**

Characteristic	N	Percent
Internship Experience		
No	7	28%
Yes	18	72%
Mfg Exp		
No	9	36%
Yes	16	64%
360-degree feedback	24	96%
No	1	4%
Yes		

*\*Note: 25 of 26 students completed the survey.*

### **Assessment Experience**

Overall, the students described their experience as helpful and important, albeit not exciting. Typical response descriptions provide insight into how the students reacted to their first 360-assessment process experience in an educational setting:

“It wasn't a very exciting process for me to use but I understand the importance of it.”

“I experienced it the first time in this class. It entailed getting feedback directly towards you and what you did.”

“I got a much more in depth look at the process than I ever have before. I have used the process previously to rate instructors and employers, and they have used it to rate me, but it was never as in depth as this course went.”

“The 360-feedback process in this course was more helpful than traditional feedback. It seems to be much more tailored to what we are actually doing and it lets you know how things are going before the very end of the semester.”

“Throughout the course I was able to assess others on my team and rate them according to their effort”

### **Benefits**

Overall, students felt that the benefit of the assessment process was identification of their strengths and weakness in order to improve during the semester based on assessment results. Typical student perceptions of benefits were:

“Knowing how we are doing and where we may need to improve on.”

“In a work environment, it allowed me to see what others considered my weaknesses and strengths. This allowed me to help others with my strengths, and work on improving my weaknesses.”

“I was able to improve and better myself in the end.”

“Much more in depth feedback than what we usually get.”

“I was able to see what I needed to work on.”

### **Difficulty**

Overall, students found it difficult to assess others and felt they were harder on themselves than others. Typical student responses about the difficulty of the assessment process were:

“I found it hard to decide on how to rate all group members.”

“I found it difficult to rate myself many times. Many times I feel I underrate myself when others will feel I did much better.”

“I found it difficult to assess some team members that are different from me. I like to do things one way and they like to do it another. I had to find even ground with them and take this in to account when rating them.”

“Figuring out how to assess others.”

### **Learning**

Overall, students learned the usefulness of the process; proper use of feedback, and the challenges and opportunities of using in a team environment. Typical student responses about learning were:

“It can be real easy to just give someone a grade, but when feedback is coming back to you from people who you directly worked with and affected you, it can be much harder to be honest and fair.”

“Good way to get in depth accurate information.”

“This class has helped me learn how to properly utilize the feedback I receive.”

“360-feedback is a very important and useful tool if used correctly. You can find areas that need improvement well before they create a major problem in a group project setting.”

“Team members may try harder when they know they are being assessed by other team members.”

### **Fairness and Accuracy**

Interestingly, the students overall felt that they rated peers fairly and accurately and that their peers did the same. Typical student responses about fairness and accuracy were:

“I did assess my peers accurately and felt they assessed me accurately as well.”

“I think I did for the most part. I evaluated every person in the group equally and went only off the project we had at hand.”

“I believe that everyone was assessed as fairly as possible considering limited contact. Obviously, in a work environment, one would have much more to base their evaluations off of rather than what are snapshots.”

“I think we all assessed each other fairly. We all understand that each one of us is slightly different and brings different strengths to our group. I think my team did a good job of understanding this and rating each other accordingly.”

“I believe I assessed them accurately. If I was on the fence I usually give them a lower rating. This is better than just giving them the benefit of the doubt, and not raising any red flags on an important issue.”

## **Impact**

Overall, student perceptions of the assessment process on their professional development were mixed. Some felt that their competencies developed independently of the process, while others felt it enhanced their development. Typical student responses about the impact were:

“I don’t feel it had much of an impact other than knowing where we were with the group. Just knowing that they were happy with what I had to offer was nice. Feeling like I helped the team along is always a confidence booster.”

“It impacted my competencies by allowing me to be able to adjust and use my competencies to improve my productivity.”

“Yes, I think the process has impacted the development of my competencies this semester. I believe this because I actually learn more when I have a certain competency that I know I’m working on.”

“I don’t think it really impacted my competency development. I feel I have developed my competencies pretty well up to this point.”

## **Conclusion, Limitations, and Implications**

The purpose of this case study was to capture student perceptions in order to understand their 360-degree assessment experience. A pre-course survey showed students had not prior experience with the 360-degree assessment process. The post-course survey (Figure 3) captured students’ perceptions, and results extracted from student responses indicated the following:



1. Overall the assessment process was helpful and important.
2. Identification of their strengths and weaknesses was the most beneficial.
3. They found it difficult to assess others.
4. They learned about the proper use of the feedback, and the challenges of using it in a team environment.
5. The students felt they and their peers assessed each other fairly.
6. Some felt that professional development was achieved independent of the process while others felt it was a direct result of the process.

It is interesting to note that students felt they were harder on themselves than others.

Quantitative results of the course assessments, reported by Baughman (2012), showed that where significant differences existed, peers ratings were, on average, lower than self-ratings.

Advantages and challenges of the 360-degree process were found in this study regarding rating of others, fairness and accuracy, and learning. Raters often rely on fragmentary information about the rates when evaluating their effectiveness (Murphy & Cleveland, 1995). Although students in this study perceived difficulty in assessing peers during a limited timeframe, benefits overall in team performance were perceived. Peer assessment help to diversify student approaches and strategies in undertaking a learning task and can deepen understanding about high- or low-quality performance (Gibbs, 1999). A rating process may even create personal change before feedback (Tornow & London, 1998). Raters learn about the performance standards of the organization as they rate themselves and each other, which makes the standards more conspicuous in the organization (Reilly et al.,

1996). Also, characteristics of feedback recipients such as gender, race, age, self-esteem, etc. are related to self-evaluation (Brutus, Fleenor, & McCalley, 1996; Peterson, 1992).

Despite the limitations of small sample size (N=19), low post-survey responses (73%), and a one semester timeframe, this study provides a glimpse into the possibilities of future 360-degree assessment implementations in higher education environments. The future benefits for students possibly include enhanced performance in a behavioral-based interview by recalling their experiences (Janz, 1982). Since the vast majority of employers use some form of the 360-degree assessment process as part of employee competency development, this can provide a job candidate with a potential advantage in obtaining employment.

The major findings in this study point to several different avenues for further research not addressed within the current study. First, this study didn't examine the aspects of culture, team movement, diversity, and work/school environment related to the 360-degree feedback process. Further research is needed to gain an understanding of these different aspects. Developing ways to minimize or overcome challenges associated with them are necessary for the 360-degree process to provide true value, not only for individuals but also for organizations/institutions in which it is implemented. Secondly, longitudinal studies are recommended involving cohorts of students in diverse academic programs, with identified competencies aligned with expectations of external stakeholders.

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## **CHAPTER 4. HOLISTIC STUDENT PROFESSIONAL DEVELOPMENT AND ASSESSMENT: A BACKWARD DESIGN APPROACH**

A manuscript prepared for submission to the *Journal of Technology Studies*

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### **Abstract**

The study of competencies opens the door to insights about humans and human talent and potential applications for their development (Boyatzis, 2009). Successful transition from academia to the twenty-first century workplace requires that college graduates acquire technical skills in their field as well as skills for interacting effectively with people (Hayward & Blackmer, 2007). This case study examines holistic student professional development through competency-based assessment. A lean manufacturing course in Midwestern University's Industrial Technology degree program served as a foundation for utilizing the "backward design" process (Wiggins & McTighe, 1998). Results indicate that holistic professional development was achieved as measured using: (a) competency assessments, and (b) captured student perceptions through structured self-reflection. Additionally, this study provides a framework for a holistic approach to student professional development and assessment.

### **Introduction**

Accreditation has provided the impetus and opportunity to re-craft how we educate students (Brumm, Mickelson, et al., 2006). Pressure from external constituents, demanding not only that departments say they are doing good things and measure how hard they are trying, but also that they measure outcomes (Walvoord, Carey, Smith, Soled, Way, & Zorn, 2000). This is clearly evident in ATMAE's *2011 Outcomes Assessment Accreditation*

*Handbook*'s objective statement of accreditation: "To ensure that programs in Technology, Management, and Applied Engineering that are accredited meet established standards and that outcome measures are used to continuously improve programs" (p. 3). Faculty are challenged to look ahead to anticipate emerging skills or a change in the emphasis on certain skills that could impact the preparedness of engineers and technology graduates for employability in the knowledge-intensive workplace.

A number of empirical studies of on-the-job excellence have clearly and repeatedly established that emotional competencies—communication, interpersonal skills, self-control, motivation, etc.—are much more important for superior job performance than are cognitive and technical abilities (King & Skakoon, 2010). In his book, *Working with Emotional Intelligence*, Goleman (2005) cited numerous studies that indicate emotional competencies are twice as important in contributing to excellence as are pure intellect and expertise. Boyatzis (2009) found that emotional, social, and cognitive intelligence competencies predict effectiveness in professional, management, and leadership roles in many sectors of society; these competencies can be developed in adults. Competency models can be used to guide individual professional development and in developing curricula that meet the needs of employers (Rothwell & Wellins, 2004).

Since the concept of competency-based human resource management was first proposed in the 1970s as a critical differentiator of performance, it has become a common practice (Boyatzis, 2009). Built upon earlier work on skills, abilities, and cognitive intelligence (Campbell, Dunnette, Lawler, & Weick, 1970), it became a tool for understanding the talent and capability of human capital within an organization. In the

1980s, a competency-based assessment tool, the 360-degree feedback process, was introduced and has become a predominant workplace reality (McCarthy & Garavan, 2001). Assessment ratings obtained from self and others constitute its core (Tornow & London, 1998). The benefit of collecting this type of data is that the person gets to see a panorama of perceptions rather than just self-perception, thus affording a more complete picture.

### **Professional Development**

Professional development (PD) can be defined in diverse ways and can take on many forms. Typical levels of professional development likely to be encountered are: individual, group or program, departmental, divisional, and professional associations. In the 1970s, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) created definitions in which three educationally-focused terms were used to descriptively summarize the types of PD: formal, nonformal, and informal education (Schwartz & Bryan, 1998). With formal education being the traditional classroom education, nonformal is “any organized, systematic, educational activity, carried on outside the framework of the formal system, to provide selected types of learning to a particular subgroup in the population” (Coombs, 1985, p. 23). Informal education is learning by association and affiliation, specifically, “the life-long process by which every person acquires and accumulates knowledge, skills, attitudes, and insights from daily experiences and exposure to the environment” (Bhola, 1983, p. 47).

We may recall that Odysseus from Homer’s *The Odyssey* entrusted his son’s education to the person he trusted with his own life, his friend, Mentor. Today, a mentor remains someone referred to as a person who is trusted, forming a relationship with the

mentee of guidance and advice, and one of many activities clustered under the broader term of professional development (Schwartz & Bryan, 1998). Over the last 20 years the central finding of a plethora of mentoring research has been the association between the presence of a mentor and career success (Allen & Eby, 2007; Kram & Ragins, 2007). A study using a career capital (human, agentic, and developmental network) framework, found that mentoring added value, above and beyond the other forms of career capital, in predicting promotions and advancement expectations (Singh, Ragins, & Tharenou, 2009), and “although mentoring mattered for career success, it represented just a portion of a constellation of career resources that are embedded within individuals and their relationships” (p. 56).

One benefit for all professionals is the transformative value of professional development (Schwartz & Bryan, 1998). Whether it is achieved individually, in groups, in formal classes, or in a workshop, the process of renewal and growth essential for human development is more likely to be found in professional development activities than in any other type of activity. As we move into a new century, organizations are finding great value in the ability to change or transform quickly in response to new technologies, new opportunities, and new demands. These changes can come from outside the organization or from within. As professionals, we assume an ethical charge and duty to maintain a level of knowledge and currency in a chosen field (Bayles, 1981).

### **Student Development**

Student development research literature has been synthesized (Knefelkamp, Widick, & Parker, 1978) into five clusters: psychosocial theories, cognitive developmental theories,

maturity models, typology models, and person-environmental interaction models. Noting that they “did not find, nor could we create, the comprehensive model of student development” (p. xi), however, these have remained as separate lines of theorizing through much of the student development literature. Constructing a holistic theoretical perspective requires focusing on intersections rather than separate constructs. Kegan (1982), a pioneer in a holistic theoretical perspective, advocated focusing on the context rather than the polarities. Despite ongoing efforts, Abes, Jones, and McEwen (2007) noted, “Few models or theories exist to understand the holistic development of college students” (p. 16). Despite leaving us with pieces in the holistic development puzzle box, student development theory renders us unable to assemble a complete picture that represents holistic student development. It serves rather as a guide and reference point.

### **Conceptual Framework**

This study examines holistic student professional development and assessment through the lens of the backward design process advocated by Wiggins and McTighe (1998). It served as the conceptual framework for this study. A process description was condensed by Field, Freeman, and Dyrenfurth (2004) into three broad steps: (a) identify desired results, (b) determine acceptable evidence, and (c) plan learning experiences and instruction.

Wiggins and McTighe stated that:

it encourages us to think about a unit or course in terms of the collected assessment evident needed to document and validate that the desired learning has been achieved, so that the course is not just content to be covered by or a series of learning activities.  
(p. 12)

This framework requires us to think about what student outcomes should be in a course, to design the course to reflect this, and to ensure that an appropriate assessment is in place to provide evidence of outcomes achievement. It is also a foundation for course and curricular continuous improvement.

The backward design process was utilized by Field et al. (2004) to advance their goal of holistic assessment of undergraduate students in an industrial technology program. They explored non-classroom-centered assessment methods and collected and analyzed preliminary data towards their goal attainment. Their work was valuable to this current study through lessons learned, purpose, and the backward design starting point recommendations as follows:

One must have a fairly specific vision of the knowledge, skills, and attitudes a technology student should develop prior to embarking on his/her career before formulating an assessment plan. In other words, what is to be assessed?

A clear understanding of the reasons for assessing technology students is critical. These reasons may originate in basic requirements to uncover information regarding students' knowledge, skills, or attitudes. One may wish to verify that students can demonstrate practical technology skills and related professional skills, or one may desire to motivate and enhance learning. Ultimately, it is the goal of the faculty to have more than just course grades to reflect student performance.

A well-structured program should include assessment by a variety of methods and from a more holistic perspective than is often currently employed. An ancillary

benefit of a more holistic assessment may be a more positive student attitude about the discipline. (p. 78)

The approach used by Field et al. (2004) guided this study's holistic student development approach, and philosophically connects with their ultimate hope, "to accelerate students' learning more effectively and efficiently, and jumpstart them into their profession" (p. 79). Holistic professional development must include a holistic assessment process to determine results. Letter grades were not included in this study.

### **Backward Course Design**

#### **Departmental Background**

Midwestern University's approach to increasing outcomes and assessment-based accreditation requirements was the development of workplace competencies (Brumm, Mickelson, et al., 2006). A collaboration with Development Dimensions International, Inc. (DDI)—a global provider of competency-based performance management tools and services—provided the department with 14 unique workplace competencies (<http://learn.ae.iastate.edu/Competencydefinitions.pdf>). These competencies were mapped to degree program outcomes. Each competency was defined clearly, concisely, and independently. Specific to each definition, a set of observable and measurable key actions was developed. The department's outcomes plan also included the development and incorporating of a competency-based assessment format, based on a Likert-style rating system.

**Step 1: Identify Desired Results**

A senior level, undergraduate industrial technology course in lean/cellular manufacturing provided the opportunity to apply the backward design. Degree program outcomes linked to workplace competencies and frequency of the department's "core" competencies in the course were used to determine the course's "top five" competencies: (a) analysis and judgment, (b) communication, (c) initiative, (d) continuous learning, and (e) teamwork. A sixth competency, engineering/technical knowledge, was also identified and connected to course content as "lean knowledge." The definitions for the course competencies can be seen in Table 1. These competencies represent desired result 1 (DR1): holistic student lean professional development and assessment.

The competencies' key action items, seen in Table 2, served as the foundation for assessments throughout the semester. A 360-degree feedback/assessment process was integrated into the course and represented desired result 2 (DR2): experience with 360-degree feedback/assessment process. A need to understand student experiences and identify course continuous improvement areas led to desired result 3 (DR3): understand students' professional development during the semester.

**Step 2: Determine Acceptable Evidence**

Each of the desired results was addressed, and the evidence was incorporated into the course design, as outlined in Figure 1. Previous work by Baughman (2012b) provided course competency-based assessment quantitative results and captured student perceptions of the 360-degree assessment process.



<p>DR1: holistic student lean professional development and assessment course competency-based assessment capture student development perceptions</p> <p><u>DR 2: experience with 360-degree feedback/assessment process</u> participation in 360-degree process capture 360-degree student experiences</p> <p><u>DR 3: understand students' professional growth</u> capture student perceptions</p>
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*Figure 1.* Desired results (DR) and corresponding evidence

Table 1

*Definitions of Course Competencies*

Competency	Definitions
Analysis and Judgment	Identifying and understanding issues, problems and opportunities; developing the relevant criteria and comparing data from different sources to draw conclusions: using effective approaches for choosing courses of action or developing appropriate solutions; taking actions that are consistent with available facts, constraints, and probably consequences
Communication	Clearly conveying information and ideas through a variety of media to individuals or groups in a manner that engages the audience and helps them understand and retain the message.
Initiative	Taking prompt action to accomplish objectives; taking action to achieve goals beyond what is required; being proactive.
Continuous Learning	Actively identifying new areas for learning; regularly creating and taking advantage of learning opportunities: using newly gained knowledge and skill on the job, and learning through applications.
Teamwork	Effectively participating as a member of a team to move the team toward completion of goals.
Engineering/Technical Knowledge	Having achieved a satisfactory level of knowledge in the relevant specialty areas of engineering/technology, science, and mathematics.

Table 2

*Course Competencies and Key Actions Assessed*

Competency	Key Actions
Analysis & Judgment	KA1 Identifies issues, problems and opportunities.
	KA2 Gathers information.
	KA3 Interprets information.
	KA4 Generates alternatives.
	KA5 Chooses appropriate action.
	KA6 Commits to action.
	KA7 Involves others.
	KA8 Values diversity.
Communication	KA1 Organizes the communication.
	KA2 Maintains audience attention.
	KA3 Adjusts to audience.
	KA4 Ensures understanding.
	KA5 Adheres to accepted conventions.
	KA6 Comprehends communication from others.
Initiative	KA1 Goes above and beyond.
	KA2 Responds quickly.
	KA3 Takes independent action.
Continuous learning	KA1 Targets learning needs.
	KA2 Seeks learning activities.
	KA3 Maximizes learning.
	KA4 Applies knowledge or skill.
	KA5 Takes risks in learning.
Teamwork	KA1 Facilitates goal accomplishment.
	KA2 Informs others on team.
	KA3 Involves others.
	KA4 Models commitment.
Engineering/Technical Knowledge	KA1 Knowledge of mathematics.
	KA2 Knowledge of science.
	KA3 Knowledge of experimental analysis.
	KA4 Knowledge of current engineering/technology tools*
	KA5 Knowledge of technology.

*Note.* Key action item used in assessment for engineering/technical knowledge competency.

**Step 3: Plan Learning Experiences and Instruction**

On the first day of class, students are introduced to course competencies and all competency-based assessments and survey processes. The initial self-assessments and

pre-course survey are completed before the end of the first day. The students acknowledged previous experience with competency-based assessment, as it is introduced during their first year of enrollment in the department. The top five course competencies identified were assessed during the semester utilizing the 360-degree feedback/assessment process and results reported (Baughman, 2012b). Additionally, a 20-question initial and final lean knowledge assessment was completed, and results are provided in Table 3. Results indicated development occurred, measured by an increase in the average final score (\*). The pre- and post-course survey results were obtained and reported (Baughman, 2012a).

Lean project teams are assembled during the first week of class. Team composition is determined based on the pre-course survey, initial lean knowledge assessment, and industry selection results. Each student team was provided an industry mentor to provide guidance on their lean project. Over the next five weeks students are in-class and experience various instruction tools aimed at competency development. This includes, but is not limited to: team assembly setup and cellular design, SMED, 5S, Kaizen, value stream mapping, JIT, standard work, and guest speakers (both former course students who are practicing lean professionals and other lean professionals). Over the course of the semester, team and individual assignments were completed, as outlined in the syllabus, and focused on competency development. The specific details of each are not presented in this study.

The teams spent the next five weeks predominantly working with industry mentors onsite. At mid-term students completed an “initial” peer/team member assessment, and the instructor provided confidential peer competency assessment results (Baughman, 2012b). Additionally, teams presented their lean project progress status, and instructor assessment

Table 3

*Paired Significance t-Test for Lean Assessment (N=25)*

Assessment	Assess	M	<i>t</i>	df	r	p
Lean Knowledge	initial	6.35	8.344	24	-0.043	0.000*
	final	8.34	-6.676			

*Note.* \* $p < .05$ , two-tailed. Assessment total = 10 points (20 questions).

and feedback, as well as peer feedback, were provided. During the 14th week, the final self and peer top five competency and lean knowledge competency assessments were completed; the instructor provided confidential peer assessment results (Baughman, 2012b). During the 15th and/or 16th week, the industry mentors attended the final student lean project team presentations. The semester ended with structured self-reflection paper assignment (Figure 2).

### **Quantitative Analysis and Results**

The top five competencies' key action items were assessed and analyzed through paired *t*-testing to detect significant average differences, and results reported (Baughman 2012b). Pre-survey results were obtained and descriptive statistics reported (Baughman, 2012a). Post-survey results were obtained and the qualitative results reported (Baughman, 2012a). The lean knowledge competency was assessed, and analyzed with SPSS 19 software utilizing paired *t*-testing. Results, provided in Table 3, indicated competency development was obtained, measured by the average increase in the final over the initial average score.

### **Qualitative Data Analysis and Results**

Twenty-three students completed the assigned final structured self-reflection. The analysis focused on questions 1, 2, 3, 4, 7, and 8 (Figure 1). Content analysis was used for

Student Final Self-Reflection Paper	
<p>Prepare a 3-5 page document/paper (single-spaced, 12-font, 1" margins) that reflects upon experience in this course during the semester. This is a self-reflection about <b>your</b> professional development/growth, and the 360-feedback assessment experience (competency assessments) per the guidelines below.</p>	
<p><b><u>Address the following in your self-reflection to describe your journey this semester:</u></b></p>	
<ol style="list-style-type: none"> <li>1. Reflect on how you've developed as a professional since your initial top 5 workplace competencies self-assessment - compare with your final self-assessment.</li> <li>2. Develop a STAR for your top 2 competencies and describe your performance in each competency:   <div style="text-align: center;">S/T=Situation/Task, A = Action, R = Result</div> </li> <li>3. Reflect upon your lean knowledge assessments. Compare pre and post-assessment results. Where were areas that you improved the most? What area(s) need more work?</li> <li>4. Reflect on the results from your self-and team members /peers' assessments (initial and final). Summarize and compare results. Describe how you feel about the accuracy and fairness of both yourself as an assessor and your team members/peers. How do you feel this 360-feedback process), impacted your professional development (growth)?</li> <li>5. Team Reflection: How well did your team function together? What were some challenges?</li> <li>6. What was your overall contribution to the success of your team?</li> <li>7. How prepared do you feel to improve processes using lean tool/techniques with a future employer?</li> <li>8. Reflect upon what you feel helped your professional development the most in this course.</li> </ol>	

*Figure 2.* Final self-reflection paper format

analyzing and interpreting the student responses (Ratcliff, 2002). The responses were entered into a spreadsheet; numbers rather than student names were entered in rows. The focus of the analysis was to bring meaning through identification of themes and patterns within student self-reflection responses. Five rounds of coding were conducted with theme being used as the coding unit in primarily looking for expressions of an idea or concept through words and phrases (Minichiello, Aroni, Timewell, & Alexander, 1990). This was done to determine the frequency of a thematic response to a specific question.

## Question 1

Students were asked to reflect on their professional development since their initial top five competency self-assessment. Overall, students felt that they developed professionally through increased lean manufacturing knowledge, professional/competency growth achievement, and coursework/assignments. The results of the thematic analysis are shown in Figure 3.

Typical student responses are as follows:

“This class seemed to be built around principles that you use as a working professional . . . I have grown professionally throughout the semester.”

“I think that initially my competencies were strong, but after the course was completed I definitely felt improvement, and felt more confident in myself as a professional.”

“. . . helped me strengthen my professional competencies.”

“I believe I have grown a lot within the specific competencies this semester.”

“I furthered my knowledge in lean manufacturing.”

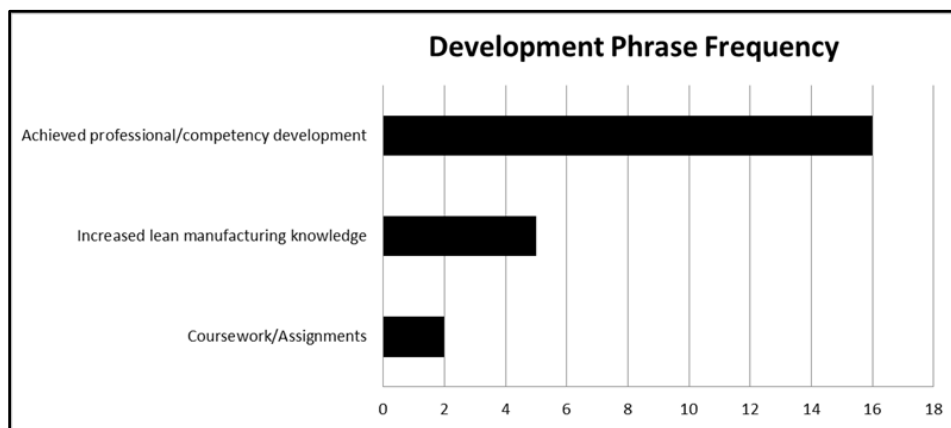


Figure 3. Phrase frequency of student responses (N=23)

## Question 2

Students were asked to develop a behavioral-based interviewing STAR (Situation/ Task, Action, and Result) for their top two competencies based on their self-assessment. The frequency of responses is provided in Figure 4. STAR involves providing an example of a past behavior which includes a situation or task, the specific action taken, and the result of the action (Byham & Pickett, 1997).

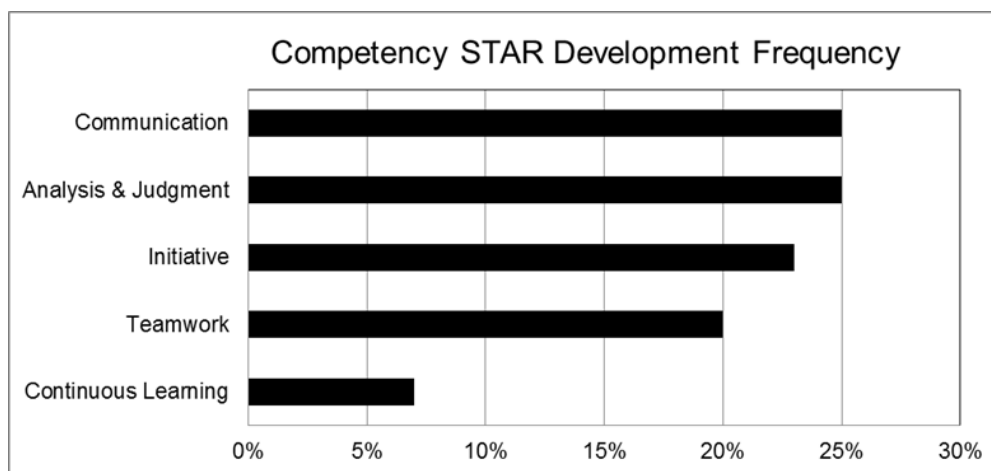
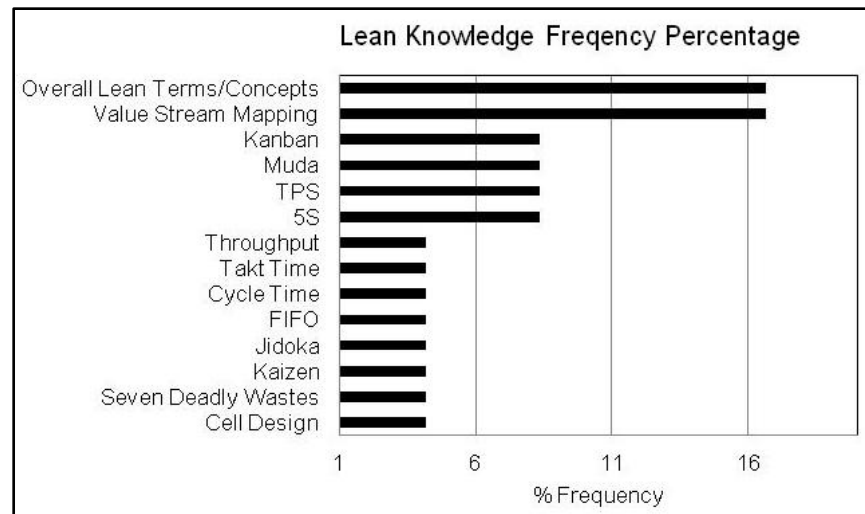


Figure 4. Self-assessment competency selection frequency for STAR development

## Question 3

Students were asked to reflect the results of their lean knowledge assessments. The results showed that 93% (13/14) of respondents achieved a higher final assessment score. A frequency distribution of the student responses, shown in Figure 5, shows the lean knowledge areas where higher final scores were achieved by the students.



*Figure 5.* Lean knowledge assessment reflection phrase frequency

Typical student responses to their lean knowledge assessment results are as follows:

“... improvements in cell design and the seven deadly wastes.”

“I couldn't name the 5's like I can now. I also know much more of the words of Japanese-origin. I felt very comfortable taking the posttest and felt as though I knew more than it showed.”

“At the beginning of the semester I received a 70%, at the end I had 100%. So there was definite improvement. The first time I took the assessment I had little knowledge of Lean philosophies and then at the end I had grasped them all.”

“Scored higher on my post lean assessment. I also completed the post-assessment in faster time. This tells me that my lean knowledge is better now than it was before.”

“My score improved more than 20%. Before taking this class I didn't know what a value stream map was, or how valuable a tool it can be to figure out where a problem could be located within an entire process from start to finish. I felt my knowledge of lean has improved 100%.”

#### **Question 4**

Students were asked to reflect on their peer assessments, accuracy and fairness, and impact of 360-degree feedback process (Figure 2). The results show that 65% felt the



process was fair/accurate and valuable, and 35% felt it was unfair/inaccurate and not valuable. A frequency of student response phrases is shown in Figure 6. Typical student responses are as follows:

“Peer feedback showed that I grew in analysis and judgment, and . . . that was fair.”

“The feedback of my peers as well as my initial and final assessments was very similar . . . my weakest competency is communication.”

“I felt I was assessed fairly, and assessed my peers fairly . . . realized areas I need to improve.”

“I felt that the feedback from my team members’ assessment was fair and accurate.”

“. . . team members were not accurate in the growth and development within the competencies.”

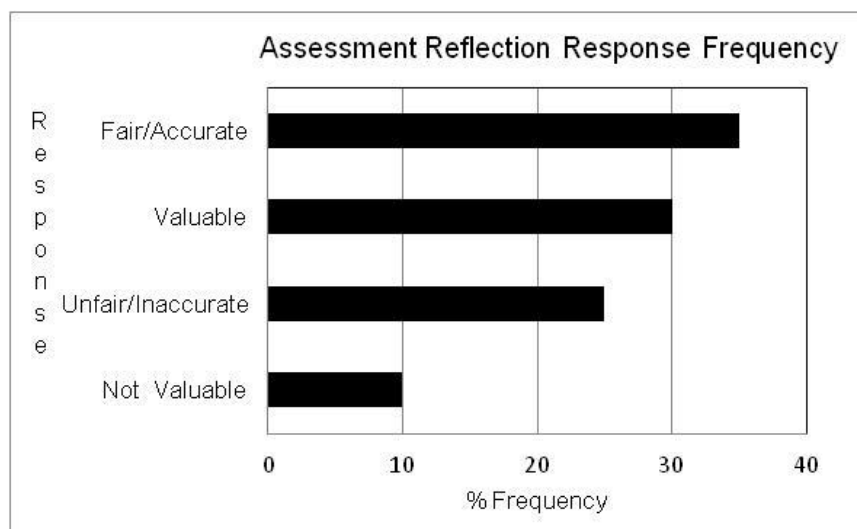


Figure 6. Self-reflection of top five competency assessments response frequency

### Question 7

Students were asked to reflect on their preparedness for future employment (Figure 2). All students, 100%, felt they were prepared from their course experience. Two students felt they weren't ready to lead but to become lean team members at their future employment.

### Question 8

Students reflected on what helped their professional development (Figure 2). The group project/industry mentor combined phrasing was the most frequently mentioned as contributing to their professional development (65%). A frequency of student response phrases is shown in Figure 7.

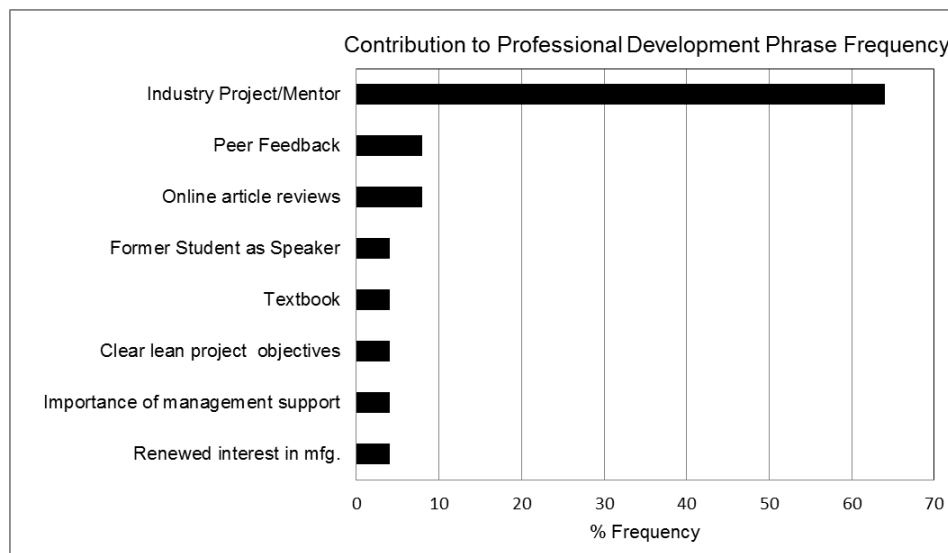


Figure 7. Contribution to professional development phrase response frequency

Typical student responses are as follows:

“Rather than going over book examples and taking tests on the practices of Lean, we actually got our hands dirty on REAL problems and really were trying to make a difference rather than just a simulated one.”

“The industry project is helpful to understand the concept of lean as well. It is important to be able to integrate the basic concepts with real world utilization.”

“Overall, working on an industry sponsored project was by far the experience that impacted my professional growth.”

“. . . working with an industry mentor it gave me a chance to practice professionalism.”

“One of the major things that helped me learning is physically going to the place of industry and applying the concepts we covered in class. Being able to have hands-on experience is the best way to learn. We get to see just how everything fits into place and how it actually works when you apply it to something new. This class has opened my eyes to new ideas and concepts I either never heard of or thought about taking into consideration. I’ve also been able to apply some of the ideas in my current place of employment.”

### **Conclusions, Limitations, and Implications**

This study successfully linked the use of competency-based assessment to the concept of holistic student professional development using the “backward design” process (Wiggins & McTighe, 1998). All course assignments and activities were not provided in detail here; the major course components, however, were reviewed to highlight the “backward course design” process in order to draw general conclusions and determine future implications. Previous work (Baughman, 2012a, 2012b) provided qualitative and quantitative results of a holistic approach to assessment and unique to industrial technology students: top five course competency assessments, descriptive pre-course survey statistic results, and student perceptions of the industry-based, 360-degree assessment process.

Students perceived professional gains based on the results of the top five competencies’ assessment, as well as lean knowledge assessment results. Self- and peer-evaluations were not entirely free of bias, which was not addressed in this case study. Students, however, perceived the top five self- and peer-assessments as valuable, as well as fair and accurate. Overall, students felt they had developed professionally as a result of their experiences in the course. It can be concluded that student professional development can be impacted and measured in a higher education environment. This was the premise behind utilizing the backward design process, which was a solid foundation in the successful

creation of a valuable professional experience for the students. The students felt prepared for their future endeavors and, for the researcher that implies success. Although this study was limited to one semester and a small sample size, it doesn't diminish the importance of its purpose nor implications for further research.

As indicated by the literature, the mentor connection has huge implications for professional development. It was not explored to a large degree in this study. Team characteristics, diversity, and culture also were not part of this study. Originally, a mentor assessment was conceptualized; circumstances, however, did not allow for this to be realized as part of this study. The implications for future research are for more in-depth examination of the mentor relationship, team characteristics, and extending the current study to future semesters. Future research using the backward design process in holistic student development and assessment are recommended to develop and/or explore other assessment tools, and to further examine those used in this study. As external pressures for outcomes based education continue, particularly with a focus on providing evidence that performance levels have been achieved, this process allows educations to design courses to meet these demands.

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## CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

### Review of Conclusions

The overarching goal of this research was to examine competency-based development and assessment as a measure of student professional development. It was driven by four central research hypotheses:

H(1): Student professional development can be measured using quantitative competency-based assessment tools.

H(2): Student professional development can be understood and measured qualitatively through captured student experiences.

H(3): A student professional development and measurement framework utilizing an industry-based, 360-degree competency assessment process can be integrated into a higher education environment.

H(4): A holistic framework for student lean professional development and assessment can be accomplished through a backward design.

Student professional development was measured quantitatively using the top five course competencies and lean knowledge competency assessments during the semester in an undergraduate course at Iowa State University. An industry-based tool, the 360-degree assessment process was successfully incorporated into the course to measure professional development. Through self- and peer- top five competency assessments, initial and final, the average results for key action items were obtained and analyzed using *t*-testing. Professional development was identified through detection of significant differences between the initial and final averaged assessed values. Gains were achieved as reflected in the higher final average assessed values within the specific action items associated with the top five competencies. The results are indicative of the complex task of comparing self-perception to

perceptions by others which involves social information processing and interpersonal insight (London, 1994). As Tornow (1993) found, self-assessments are, on average, higher than assessments by others, including peers. Psychological mechanisms related to how we operate in social environments may become impediments to accurate self-assessment.

The integration of an industry-based competency assessment process, the 360-degree process, allowed students to experience professional development. This was achieved through the initial and final assessments of both self and peer. Through integration of a 360-degree assessment process into the course to measure professional development, a framework for utilizing this industry-based tool was provided for further use in educational environments and to address and accept H(1) and H(3). Although the results are unique to the industry technology students enrolled in the course, this framework can be utilized in degree programs both inside and outside of the department.

A post-course survey was implemented as one of the methods used to capture the student experiences with the 360-degree assessment. Advantages and challenges of the 360-degree process were found regarding rating of others, fairness and accuracy, and learning. Raters often rely on fragmentary information about the rates when evaluating their effectiveness (Murphy & Cleveland, 1995). Although students in this study perceived difficulty in assessing peers during a limited timeframe, overall benefits in team performance were perceived. The findings pointed to benefits, impact, and learning aligned with peer-assessment regarding helping to diversify student approaches and strategies in undertaking a learning task and can deepen understanding about high- or low-quality performance (Gibbs, 1999). Raters learn about the performance standards of the organization

as they rate themselves and each other, which makes the standards more conspicuous in the organization (Reilly, 1996).

A second qualitative measure, the structured self-reflection paper, was used to capture student perceptions of the professional journey during the semester. Overall, results showed that students felt they had developed professionally and were prepared for their future endeavors as a result of their experiences in the course. Over the last 20 years, the central finding of a plethora of mentoring research has been the association between the presence of a mentor and career success (Allen & Eby, 2007; Kram & Ragins, 2007). Additionally, recent studies have confirmed that the experiential workplace was one of the settings most likely to develop and demonstrate these competencies, while the traditional classroom was the least likely (Brumm, Hanneman, et al., 2006). Thus, it was not surprising that the industry project/mentor experience was expressed as contributing the most to their professional development.

The use of the both the pre- and post-course assessments provided insight into the students' previous 360-degree assessment experience and captured the result of participation in the process over the semester. The pre-course survey revealed that students did not have prior experience in the 360-degree assessment process. In the beginning of the course, the students are introduced to both the 360-degree assessment process and the top five competencies. Included in this is the discussion of the increasing employer expectations of competency development and assessment in the workplace environment. Many companies have a structured approach to competency development and assessment, and the 360-degree process is the choice for the majority of employers. Additionally, companies that provided

industry projects, as well as the researcher's own past experience, shows that typically a set of 5–10 “core” company competencies are the foundation for all employee development and assessment. More “leadership” and over higher level competencies are generally added as part of the organizational promotional progression/hierarchy system. Competency-based assessment is the professional development measurement method used predominantly in industry-employer settings.

The course surveys and structured self-reflection were designed to capture the experiences the students had with both the 360-degree assessment process, as well as the entire professional development experience in the course. This was developed to address and accept H(2) and was based on the instructor's previous experience with employee surveys within an industry setting. Employee surveys are used to capture employee experiences and understand the views of the workforce. They can be done as part of the general HR process or to capture a particular snapshot in time during an implementation process, such as the 360-degree assessment process. The intention of the course qualitative tools used to capture this information was twofold: (a) to understand the experiences through the eyes of the students, and (b) to share results with colleagues and solicit recommendations as input into improvements for future course implementations.

The holistic professional student development and assessment approach was driven by the empirical research findings of on-the-job excellence, which have found that emotional competencies, such as communication, interpersonal skills, self-control, motivation, etc., are much more important for superior job performance than are cognitive and technical abilities (King & Skakoon, 2010). It was also inspired by the instructor's previous experience

working with industry colleagues in attempting to identify “well-rounded” engineering and technology hires. Thus the holistic student development and assessment approach was built upon the top five competencies in addition to the lean knowledge assessment (KA4) as quantitative measures. The survey and self-reflection qualitative tools were used to capture student perceptions of their professional journey throughout the semester. The backward design (Wiggins & McTighe, 1998) process, as well as the holistic assessment approach (Field et al., 2004), provided a foundational approach to designing a holistic student professional development and assessment in the course. In integrating both the quantitative and qualitative tools and analyzing their results to understand the holistic student lean professional development and assessment, a framework was developed.

Employers are increasingly using behavioral based interviewing (BBI) as an approach to hiring, competency self-development in the evaluation process, and self-reflection is also typically part of this process as well. Thus the holistic student development approach provides benefits, both for the student and the higher education institution. Although the results are unique to the students enrolled within this industrial technology course, the results capture their holistic journey throughout the semester. The impetus of a holistic student lean professional framework is to prepare students for the employer hiring and promotional expectations. Through the backward design approach, the holistic student lean development and assessment framework was developed to address and accept H(4). Although unique to this lean manufacturing course experience, this framework can be utilized in higher education to measure holistic professional development of students.

Overall, conclusions from this work support the central hypotheses that prompted the research path. Student professional development and assessment can be measured using both quantitative and qualitative tools. Holistically, this can be achieved through the lens of backward design using industry-based assessment tools and concepts. Additionally, this framework can be successfully implemented into an educational setting to assess student professional development.

### **Recommendations for Future Work**

Despite the study's limitations, the implications for future research are evident. The major findings point to several avenues for further research, including those not addressed within the current study:

- Continue the current study over several semesters, utilizing results to continuously improve and provide results to colleagues.
- Future studies should include dimensions of culture, team movement, diversity, and work/school environment related to the 360-degree feedback process.
- Longitudinal studies are recommended involving cohorts of students in diverse academic programs with identified competencies aligned with expectations of external stakeholders.
- The mentor aspect of student professional development and assessment should be explored to understand its impact.
- Continue studies in higher education on the backward design process to gain further understanding of a holistic view of course/curricular design and the impact on student development.

- Future studies to investigate the hypotheses that use of industrial-based assessment tools increase student competency development more than typical educational tools.

This study provides an inkling of the possibilities to not only improve our approach to student development and assessment, but also in curricular improvement efforts that better prepare students for their professional endeavors. The link between educational experiences and employer expectations is critical for student success in future employment endeavors. Competency-based professional development and assessment provides a direct link between educational experiences and industry expectations.

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## APPENDIX A. COMPETENCY ASSESSMENT TOOL

Use the following scale to rate how the key action is performed. When given the opportunity, how often does this person/you perform this action?

1. Never or almost never: This person hardly ever performs the action.
2. Seldom: This person often does not perform the action.
3. Sometimes: This person performs the action about half of the time.
4. Often: This person performs the action on most occasions.
5. Always or almost always: This person performs the action just about every time.

\* Your Name

\* Name of individual you are assessing (Self or team/peer member)

**Analysis and Judgment: Identifies issues, problems and opportunities - Recognizes issues, problems, or opportunities and determines whether action is needed.**

- 1
- 2
- 3
- 4
- 5

**Analysis and Judgment: Gathers Information - Identifies the need for and collects information to better understand issues, problems, and opportunities.**

- 1
- 2
- 3
- 4
- 5

**Analysis and Judgment: Interprets Information - Integrates information from a variety of sources; detects, trends, association, and cause-effect relationships.**

- 1
- 2
- 3
- 4
- 5

Analysis and Judgment: Generates alternatives - Creates relevant options for addressing problems/opportunities and achieving desired outcomes.

- 1
- 2
- 3
- 4
- 5

Analysis and judgment: Chooses appropriate action - Formulates clear decision criteria; evaluates options by considering implications and consequences; chooses an effective option.

- 1
- 2
- 3
- 4
- 5

Analysis and judgment: Commits to Action - Implements decisions or initiates action within a reasonable time.

- 1
- 2
- 3
- 4
- 5

Analysis and judgment: Involves others - Includes others in the decision-making process as warranted to obtain good information, make the most appropriate decisions, and ensures buy-in and understanding of the resulting decisions.

- 1
- 2
- 3
- 4
- 5
- 4

Analysis and judgment: Values diversity - Embraces and values diverse collection of inputs, values, perspectives, and thought paradigms in approaching the application of technology to products and processes.

- 1
- 2
- 3
- 4
- 5

Communication: Organizes the communication - Clarifies purpose and importance; stresses major points; follows logical sequence.

- 1
- 2
- 3
- 4
- 5

Communication: Maintains audience attention - Keeps the audience engaged through use of techniques' such as analogies, illustrations, body language, and voice inflections.

- 1
- 2
- 3
- 4
- 5

Communication: Adjusts to audience - Frames message in line with audience experience, background, and expectations; uses terms, examples, and analogies that are meaningful to the audience.

- 1
- 2
- 3
- 4
- 5

Communication: Ensures understanding - Seeks input from audience, checks understanding; presents message in different ways to enhance understanding.

- 1
- 2
- 3
- 4
- 5

Communication: Adheres to accepted conventions - Uses syntax, pace, volume, diction, and mechanics appropriate to the media being used.

- 1
- 2
- 3
- 4
- 5

Communication: Comprehends communication from others - Attends to messages from others; correctly interprets messages and response appropriately.

- 1
- 2
- 3
- 4
- 5

Continuous Learning: Targets learning needs - Seeks and uses feedback and other sources of information to identify appropriate areas for learning.

- 1
- 2
- 3
- 4
- 5

Continuous Learning: Seeks learning activities - Identifies and participates in appropriate learning activities (e.g., courses, reading, self-study, coaching, & experiential learning) that help full learning needs.

- 1
- 2
- 3
- 4
- 5

Continuous Learning: Maximizes learning - Actively participates in learning activities in a way that makes the most of the learning experience (e.g., takes notes, asks questions, critically analyzes information, keeps on-the-job application in mind, does required tasks).

- 1
- 2
- 3
- 4
- 5

Continuous Learning: Applies knowledge or skill - Puts new knowledge, understanding, or skill to practical use on the job; furthers learning through trial and error.

- 1
- 2
- 3
- 4
- 5

Continuous Learning: Takes risks in learning - Puts self in unfamiliar or uncomfortable situation in order to learn; asks questions at the risk of appearing foolish; takes on challenging or unfamiliar assignments.

- 1
- 2
- 3
- 4
- 5

Initiative: Goes above and beyond - Takes action that goes beyond job requirements in order to achieve objectives.

- 1
- 2
- 3
- 4
- 5

Initiative: Responds quickly - Takes immediate action when confronted with a problem or when made aware of a situation.

- 1
- 2
- 3
- 4
- 5

Initiative: Takes independent action - Implements new ideas or potential solutions without prompting; does not wait for others to take action or to request action.

- 1
- 2
- 3
- 4
- 5

Teamwork: Facilitates goal accomplishment - Makes procedural or process suggestions for achieving team goals or performing team functions; provides necessary resources or helps to remove obstacles to help the team accomplish its goals.

- 1
- 2
- 3
- 4
- 5

Teamwork: Informs others on team - Shares important or relevant information with the team.

- 1
- 2
- 3
- 4
- 5

Teamwork: Involves others - Listens to and fully involves others in team decisions and actions; values and uses individual differences and talents.

- 1
- 2
- 3
- 4
- 5

Teamwork: Models commitment - Adheres to the team's expectations and guidelines; fulfills team responsibilities; demonstrates personal commitment to the team.

- 1
- 2
- 3
- 4
- 5

Comments:

## APPENDIX B. STUDENT STRUCTURED SELF-REFLECTION

### Student Final Self-Reflection Paper

Prepare a 3-5 page document/paper (single-spaced, 12-font, 1" margins) that reflects upon experience in this course during the semester. This is a self-reflection about **your** professional development/growth, and the 360-feedback assessment experience (competency assessments) per the guidelines below.

#### **Address the following in your self-reflection to describe your journey this semester:**

1. Reflect on how you've developed as a professional since your initial top 5 workplace competencies self-assessment - compare with your final self-assessment.
2. Develop a STAR for your top 2 competencies and describe your performance in each competency:  
  
S/T=Situation/Task, A = Action, R = Result
3. Reflect upon your lean knowledge assessments. Compare pre and post-assessment results. Where were areas that you improved the most? What area(s) need more work?
4. Reflect on the results from your self-and team members /peers' assessments (initial and final). Summarize and compare results. Describe how you feel about the accuracy and fairness of both yourself as an assessor and your team members/peers. How do you feel this 360-feedback process), impacted your professional development (growth)?
5. Team Reflection: How well did your team function together? What were some challenges?
6. What was your overall contribution to the success of your team?
7. How prepared do you feel to improve processes using lean tool/techniques with a future employer?
8. Reflect upon what you feel helped your professional development the most in this course.



## APPENDIX C. TOP FIVE COMPETENCY SELF-ASSESSMENTS

Paired Significance Means t-Test for Competency Self- Assessments (N=24)

Competency	Assess	M	SD	t	df	r	p
<b>1. Analysis &amp; Judgment</b>							
Chooses appropriate action	initial	3.96	0.464	-1.446	23	0.235	0.162
	final	4.13	0.448				
Gathers information	initial	4.04	0.550	-0.526	23	-0.018	0.604
	final	4.13	0.537				
Generates alternatives	initial	3.92	0.584	-2.326	23	0.306	0.029*
	final	4.25	0.608				
Identifies issues, problems, and opportunities	initial	3.83	0.581	-3.464	23	0.370	0.002*
	final	4.33	0.670				
Interprets information	initial	3.94	0.648	-0.901	23	-0.308	0.377
	final	4.13	0.612				
Commits to action	initial	4.08	0.654	-0.089	23	-0.055	0.382
	final	4.25	0.608				
Involves others	initial	4.25	0.590	0.000	23	0.539	1.000
	final	4.25	0.752				
Valuing diversity	initial	3.98	0.651	-1.394	23	0.377	0.177
	final	4.20	0.592				
<b>2. Communication</b>							
Adheres to accepted conventions	initial	3.88	0.680	-1.664	23	-0.066	0.110
	final	4.17	0.482				
Adjusts to the audience	initial	3.94	0.631	-1.813	23	0.241	0.830
	final	4.19	0.404				
Comprehends communication from others	initial	3.85	0.744	-1.013	23	0.110	0.322
	final	4.04	0.606				
Ensures understanding	initial	3.96	0.624	-0.647	23	-0.098	0.524
	final	4.08	0.654				
Maintains audience attention	initial	3.73	0.659	-1.764	23	-0.094	0.910
	final	4.08	0.670				
Organizes the Communication	initial	3.92	0.637	-2.299	23	0.351	0.031*
	final	4.21	0.404				
<b>3. Initiative</b>							
Goes above and beyond	initial	3.75	0.626	-2.908	23	0.399	0.008*
	final	4.17	0.654				
Responds quickly	initial	4.00	0.643	-0.558	23	0.309	0.583
	final	4.08	0.602				
Takes independent action	initial	3.85	0.651	-1.313	23	-0.245	0.202
	final	4.13	0.630				
<b>4. Continuous Learning</b>							
Applies knowledge or skill	initial	4.17	0.602	-1.479	23	0.292	0.015*
	final	4.38	0.557				
Maximizes learning	initial	3.98	0.699	-2.132	23	0.260	0.044*
	final	4.33	0.637				
Seeks learning activities	initial	3.81	0.548	-1.326	23	0.051	0.198
	final	4.04	0.674				
Takes risks in learning	initial	3.60	0.737	-1.297	23	0.118	0.207
	final	3.85	0.683				
Targets learning needs	initial	3.85	0.744	-1.556	23	0.119	0.133
	final	4.13	0.540				
<b>5. Teamwork</b>							
Facilitates goal accomplishment	initial	3.94	0.558	-2.563	23	0.316	0.017*
	final	4.27	0.531				
Informs others on team	initial	4.33	0.545	-1.334	23	0.252	0.195
	final	4.52	0.580				
Involves others	initial	4.29	0.550	-0.514	23	0.501	0.612
	final	4.35	0.634				
Models commitment	initial	4.17	0.637	-2.717	23	0.517	0.012*
	final	4.52	0.651				

Note. \*p<.05, two-tailed.

## APPENDIX D. TOP FIVE COMPETENCY SELF- vs. PEER-ASSESSMENTS

Paired Significance Means t-Test for Competency Self vs, Peer Assessments (N=24)

Competency	Assess	M <sub>self</sub>	M <sub>peer</sub>	t	df	r	p
<b>1. Analysis &amp; Judgment</b>							
Chooses appropriate action	initial	3.96	3.84	1.633	23	0.534	0.116
	final	4.13	4.06	0.677		-0.243	0.505
Gathers information	initial	4.04	3.92	1.136	23	-0.054	0.268
	final	4.13	4.06	0.748		0.052	0.462
Generates alternatives	initial	3.92	3.87	0.655	23	0.208	0.519
	final	4.25	4.02	1.875		0.040	0.074
Identifies issues, problems, and opportunities	initial	3.83	3.95	-0.703	23	0.091	0.489
	final	4.33	4.03	1.976		0.033	0.060
Interprets information	initial	3.94	3.86	0.628	23	0.160	0.536
	final	4.13	4.07	0.542		0.254	0.593
Commits to action	initial	4.08	3.87	1.724	23	0.188	0.098
	final	4.25	3.98	1.777		-0.055	0.089
Involves others	initial	4.25	3.88	3.037	23	0.018	0.006*
	final	4.25	4.00	1.474		-0.027	0.154
Valuing diversity	initial	3.98	3.91	0.601	23	0.238	0.554
	final	4.20	4.00	1.595		0.354	0.125
<b>2. Communication</b>							
Adheres to accepted conventions	initial	3.88	3.86	0.256	23	-0.043	0.800
	final	4.17	4.02	1.245		0.044	0.226
Adjusts to the audience	initial	3.94	3.86	0.465	23	-0.262	0.647
	final	4.19	4.09	1.169		0.166	0.254
Comprehends communication from others	initial	3.85	3.97	-0.593	23	0.064	0.559
	final	4.04	4.10	-0.134		0.064	0.895
Ensures understanding	initial	3.96	3.88	0.685	23	0.056	0.500
	final	4.08	4.02	0.571		0.038	0.573
Maintains audience attention	initial	3.73	3.80	-0.363	23	-0.105	0.720
	final	4.08	4.04	0.447		-0.030	0.659
Organizes the Communication	initial	3.92	3.86	0.602	23	0.028	0.553
	final	4.21	4.08	1.479		0.262	0.153
<b>3. Initiative</b>							
Goes above and beyond	initial	3.75	3.72	0.392	23	0.211	0.699
	final	4.17	3.80	2.295		0.097	0.031*
Responds quickly	initial	4.00	3.76	1.747	23	-0.129	0.094
	final	4.08	3.89	1.425		0.143	0.168
Takes independent action	initial	3.85	3.78	0.617	23	-0.174	0.544
	final	4.13	3.99	0.984		0.074	0.335
<b>4. Continuous Learning</b>							
Applies knowledge or skill	initial	4.17	3.95	1.736	23	-0.121	0.096
	final	4.38	4.11	1.684		-0.245	0.106
Maximizes learning	initial	3.98	3.90	0.517	23	-0.243	0.610
	final	4.33	4.06	1.559		-0.396	0.133
Seeks learning activities	initial	3.81	3.81	0.194	23	-0.089	0.848
	final	4.04	3.97	0.536		0.023	0.597
Takes risks in learning	initial	3.60	3.78	-0.999	23	-0.099	0.328
	final	3.85	3.94	-0.336		-0.036	0.740
Targets learning needs	initial	3.85	3.80	0.391	23	-0.420	0.699
	final	4.13	3.99	1.215		0.116	0.237
<b>5. Teamwork</b>							
Facilitates goal accomplishment	initial	3.94	3.84	0.761	23	-0.283	0.454
	final	4.27	4.07	1.521		-0.185	0.142
Informs others on team	initial	4.33	3.93	3.328	23	-0.047	0.003*
	final	4.52	4.07	3.040		0.066	0.006*
Involves others	initial	4.29	3.96	2.876	23	0.131	0.009*
	final	4.35	4.10	1.985		0.283	0.059
Models commitment	initial	4.17	4.23	-0.071	23	-0.264	0.944
	final	4.52	4.01	3.112		0.091	0.005*

Note. \*p<.05, two-tailed.

## APPENDIX E. TOP FIVE COMPETENCY PEER-ASSESSMENTS

Paired Significance Means t-Test for Competency Peer Assessments (N=24)

Competency	Assess	M	SD	t	df	r	p
<b>1. Analysis &amp; Judgment</b>							
Chooses appropriate action	initial	3.84	0.371	-2.652	23	0.51	0.014*
	final	4.06	0.461				
Gathers information	initial	3.92	0.288	-1.562	23	0.47	0.131
	final	4.06	0.514				
Generates alternatives	initial	3.87	0.327	-1.059	23	0.26	0.300
	final	4.02	0.503				
Identifies issues, problems, and opportunities	initial	3.95	0.377	-1.028	23	0.66	0.314
	final	4.03	0.535				
Interprets information	initial	3.86	0.338	-2.452	23	0.57	0.022*
	final	4.07	0.521				
Commits to action	initial	3.87	0.336	-0.998	23	0.31	0.328
	final	3.98	0.584				
Involves others	initial	3.88	0.330	-1.319	23	0.55	0.199
	final	4.00	0.581				
Valuing diversity	initial	3.91	0.394	-0.780	23	0.41	0.433
	final	4.00	0.577				
<b>2. Communication</b>							
Adheres to accepted conventions	initial	3.86	0.459	-1.652	23	0.47	0.111
	final	4.02	0.494				
Adjusts to the audience	initial	3.86	0.373	-3.037	23	0.62	0.006*
	final	4.09	0.048				
Comprehends communication from others	initial	3.97	0.329	-1.528	23	0.58	0.139
	final	4.10	0.524				
Ensures understanding	initial	3.88	0.303	-1.810	23	0.54	0.082
	final	4.02	0.457				
Maintains audience attention	initial	3.80	0.337	-2.732	23	0.45	0.011*
	final	4.04	0.465				
Organizes the Communication	initial	3.86	0.350	-2.706	23	0.62	0.012*
	final	4.08	0.528				
<b>3. Initiative</b>							
Goes above and beyond	initial	3.72	0.364	-0.606	23	0.42	0.550
	final	3.80	0.692				
Responds quickly	initial	3.76	0.429	-0.943	23	0.27	0.355
	final	3.89	0.670				
Takes independent action	initial	3.78	0.374	-1.728	23	0.16	0.096
	final	3.99	0.534				
<b>4. Continuous Learning</b>							
Applies knowledge or skill	initial	3.95	0.183	-1.614	23	0.1	0.119
	final	4.11	0.513				
Maximizes learning	initial	3.90	0.309	-1.700	23	0.44	0.101
	final	4.06	0.538				
Seeks learning activities	initial	3.81	0.395	-2.064	23	0.61	0.049*
	final	3.97	0.048				
Takes risks in learning	initial	3.78	0.273	-2.101	23	0.53	0.046*
	final	3.94	0.439				
Targets learning needs	initial	3.80	0.260	-2.080	23	0.41	0.048*
	final	3.99	0.504				
<b>5. Teamwork</b>							
Facilitates goal accomplishment	initial	3.84	0.415	-2.830	23	0.54	0.009*
	final	4.07	0.463				
Informs others on team	initial	3.93	0.035	-1.311	23	0.43	0.202
	final	4.07	0.584				
Involves others	initial	3.96	0.033	-1.227	23	0.34	0.213
	final	4.10	0.592				
Models commitment	initial	4.23	0.487	1.874	23	0.48	0.073
	final	4.01	0.665				

Note. \* $p < .05$ , two-tailed.

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## APPENDIX F. LEAN KNOWLEDGE SELF-ASSESSMENT

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### 1. MUDA

(Points: 0.5)

The term "muda" refers to:

- 1. waist
- 2. waste
- 3. muddy
- 4. lean
- 5. value stream

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### 2. Value Stream

(Points: 0.5)

A value stream is:

- 1. only value added actions/activities
- 2. both value added and non-value added actions/activities
- 3. only non-value added actions/activities
- 4. the entire production system
- 5. computer software

---

### 3. VSM

(Points: 0.5)

A value stream map is:

- 1. New computer software for production flow
- 2. tool that helps you see the product flow
- 3. Flow of customer cash payments
- 4. something to draw during a boring meeting
- 5. map of value-added actions/activities

---

### 4. Takt

(Points: 0.5)

Takt Time refers to:

- 1. The fastest speed that a value stream must operate at to meet customer demand.
- 2. The speed that a value stream must operate at to meet customer demand.
- 3. The speed of a production line during peak levels of customer demand.
- 4. The total time it takes for quality improvement to be implemented.
- 5. The speed at which your value stream must operate at in order to receive bonus.

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**5. 5-Whys**

(Points: 0.5)

The 5-Why method refers to:

- 1. Root cause analysis tool.
- 2. A countermeasure used once root cause is determined.
- 3. A job analysis tool.
- 4. A statistical quality control technique.
- 5. A CSI interrogation technique.

---

**6. 5-S**

(Points: 0.5)

You team is performing 5S, in what order are you accomplishing the 5Ss?

- 1. Sustain, Standardize, Shine, Sort, Stabilize
- 2. Sort, Stabilize, Shine, Standardize, Sustain
- 3. Shine, Standardize, Sort, Stabilize, Sustain
- 4. Standardize, Shine, Sort, Sustain, Stabilize
- 5. Self-discipline, Sort, Shine, Stabilize, Sustain

---

**7. Cell Layout**

(Points: 0.5)

Your team is assigned to develop the most efficient manufacturing cell layout utilizing a U-Shaped configuration, which of the following things will you keep in mind?

- 1. Minimize the square-footage for each operation.
- 2. Allow space for small containers of detail parts.
- 3. Keep the length of conveyors to a minimum.
- 4. The process should flow in a counterclockwise direction (most people are right-handed)
- 5. Operators should be located inside a U.

---

**8. Kanban**

(Points: 0.5)

An effective kanban system will result in:

- 1. A large amount of material flowing through the factory.
- 2. Material being delivered only in small quantities as needed.
- 3. Material handling increases to keep up with demand.
- 4. A delicious chocolate candy bar.
- 5. A Policy deployment process.

---

**9. Calculating Takt Time**

(Points: 0.5)

Take Time is calculated by:

- 1. Dividing the number of shifts by number of employees per shift.
- 2. Net available time for identified time period divided by customer demand for the same time period.
- 3. Net Available time for identified time period divided by employees time on the job.
- 4. Net available production time divided by time per unit.
- 5. Net available time for trucks to wait at the shipping dock divided by forklift load time.

---

**10. Cycle Time**

(Points: 0.5)

Cycle Time refers to (select all that apply):

- 1. Average elapsed time from the moment one good piece is completed until one bad piece is completed.
- 2. Average elapsed time from the moment one good piece is completed until the moment the next good piece is completed.
- 3. Average time for employees to complete their lunch break.
- 4. Average time for a value stream map to be completed.
- 5. The reciprocal of the production rate.

**11. Throughput Time**

(Points: 0.5)

Throughput Time refers to:

- 1. The reciprocal of cycle time multiplied by takt time.
  - 2. The time that a product spends moving through the factory.
  - 3. The time it takes for work in process to be counted by inventory specialist.
  - 4. The time it takes people to startup a machine and run two units through it.
  - 5. The time it takes for a part changeover to occur.
- 

**12. Work in Process**

(Points: 0.5)

Work in Process refers to:

- 1. Machines sitting idle waiting for material delivery.
  - 2. The volume of in-process inventory in the factory.
  - 3. The material handler's job.
  - 4. The volume of work that needs to be completed before a shift ends.
  - 5. Products that need to be re-worked prior to shipping to the customer.
- 

**13. Jidoka**

(Points: 0.5)

Jidoka refers to:

- 1. The machine's ability to make perfect parts.
- 2. A machine's ability to make judgments like that of a human.
- 3. The ability for workers to make decisions without management interference.
- 4. The ability of machines to run at a constant pace during production.
- 5. The synchronicity of the entire facility during peak customer demand.

**14. Flow in Manufacturing**

(Points: 0.5)

What is flow?

- 1. Rushing water throughout the factory.
  - 2. The continuous movement of material through the manufacturing processes and on to the customer.
  - 3. A good relationship between the customer and the factory's purchasing department.
  - 4. Electronic Data System Interchange between the factory and the customer.
  - 5. The ability for material handlers to efficiently move material from processing to shipping.
- 

**15. Pull System**

(Points: 0.5)

A Pull System refers to:

- 1. The operator pulling a rope to stop the line.
  - 2. The basic premise not to make a part until the next operation needs it.
  - 3. The basic premise to make parts up ahead of the next line so that it is stocked.
  - 4. The premise to go to the next process and ask the operator what it will take to shut down the process.
  - 5. The basic premise that a tug-of-war will occur on a daily basis in the factory.
- 

**16. One Piece Flow**

(Points: 0.5)

One-Piece Flow affects inventory by:

- 1. Making operators wait for material handlers to get them raw materials to them.
- 2. Increasing work in progress so that machine operators now they must work faster to reduce it.
- 3. Not allowing parts to collect between production operations in the factory.



**17. Cellular Operations**

(Points: 0.5)

Cellular Operations refers to:

- 1. Microbiological aspects of human and machine interaction.
- 2. Operations must be tied together in work cells indicative of balance and one-piece flow.
- 3. Conducting operations via a cell phone in your car.
- 4. Allowing operations to be spread across the factory in order to provide more floor space for material handlers.
- 5. Increasing forklift space between storage rack cells.

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**18. TPS**

(Points: 0.5)

TPS stands for:

- 1. Total Production System
- 2. Toyota Production System
- 3. Total Product Development System
- 4. Typical Production System
- 5. Total Process System

---

**19. Cell Design**

(Points: 0.5)

There are 4 ways in which a cell can be designed, however, generally what shape is considered to be the most effective?

- 1. S-shaped cell.
- 2. U-Shaped cell.
- 3. L-Shaped cell.
- 4. I-Shaped cell.
- 5. None of the above.

**20. 7 Deadly Wastes**

(Points: 0.5)

Typically there are 7 Deadly Wastes that inhibit the success of one-piece flow implementation in a factory. Some say the 8th Deadly Waste is "Under utilization of people". What are the common 7 Deadly Wastes?

- 1. Inventory, teams, operators using more than one machine, JIT, supplier material, floor space, inspector training
- 2. Waiting, Processing, Over-Production, Motion, Defects, Inventory, Transportation
- 3. Material handling, Shipping wait time, loading trucks on the dock, smoking outside, outside breaks, unloading trucks in receiving, parking lot space
- 4. Meetings, desk time, conversations, processing, downtime, uptime, changeover
- 5. In-process inventory, heijunka, muda, steps to correct, rework, retest, inspection

**APPENDIX G. PRE- AND POST-COURSE SURVEYS****Pre-Course Survey**

- |  |     |    |
|--|-----|----|
| 1. Intern Experience?  | Yes | No |
| 2. Manufacturing Experience?   | Yes | No |
| 3. a. Have you used 360-feedback before?                                       | Yes | No |
| b. If yes, please describe your experience, specify context( internship, etc.) |     |    |

**Post-Course Survey**

- |  |
|--|
| 1. Prepare a one paragraph description of your 360-degree experience this semester.          |
| 2. What were the benefits of the 360-degree feedback process?                                |
| 3. What did you find difficult about the 360-degree feedback process?                        |
| 4. What did you learn from the 360-degree feedback process?                                  |
| 5. Do you think that you assessed your peers fairly and accurately? Describe why or why not. |
| 6. Describe how the 360-feedback process impacted your professional development.             |